

New Scientist

WEEKLY 26 August 2023

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The alarming new ways you're being tracked online - and how to fight back

SENSORY SUPERHIGHWAY
How hijacking the vagus nerve could boost our health

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NS Live

The keys to kindness

Psychology lecturer and broadcaster Claudia Hammond will be at New Scientist Live on 7 October to explore how understanding our minds can help us in everyday life. Her latest book, *The Keys to Kindness*, covers the world's largest public science project on the subject of kindness.

[newscientist.com/nsimag](https://www.newscientist.com/nsimag)

Tour

Land of fire and ice: Iceland

Join volcanologist Tamsin Mather on an unforgettable tour of Iceland's turbulent landscapes. Marvel at erupting geysers, hot springs and bubbling fumaroles. In the day, you will get up close to stunning glaciers, waterfalls and parting tectonic plates. At night, you will have the chance to glimpse the aurora borealis. This tour runs for eight days from 27 October and costs £3099.

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Podcast

Weekly

In this episode, the team unpicks the reasons why much of the world has recently experienced such extreme heat, and tells you everything you need to know about the new "Eris" covid-19 variant. There is also an update on Ötzi the mummified iceman's ancestry, which is all thanks to new genomic techniques. Plus, why intelligent aliens – if they exist – could be forced to live low-technology lives due to a lack of oxygen.

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Podcast



JASON REDMOND/AFP VIA GETTY IMAGES

Covid-19 variant How worried should we be about "Eris"?

Tour



MARTIN ZWICK/REDA&CO/UNIVERSAL IMAGES GROUP VIA GETTY IMAGES

Fire and ice Marvel at geysers and glaciers in stunning Iceland

Video

Saving seagrass

A project to plant and protect up to 50 square kilometres of *Posidonia oceanica* seagrass in the Mediterranean Sea by 2050 is under way in Sardinia, Italy. Seagrass is renowned for its ability to capture carbon up to 35 times faster than tropical rainforests. It also creates marine habitats and protects coastal communities, but is in severe decline globally.

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Newsletter

Fix the planet

What is going to replace gas boilers? Infrared radiators and even hydrogen heaters have been vying for the top spot. Now, it seems ground source heat pumps – long considered a niche solution for those with land and money – could be the winner. Reporter Madeleine Cuff looks at the technology's rise to fame.

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Newsletter

"A new model for ground source heat pumps could bring this technology to the masses"



Essential guide

What drives the ageing process? What can science tell us about the stages of life? And how can we use the latest research to live healthily into old age? This New Scientist Essential Guide offers some fresh insight. Available to download in the New Scientist app or to purchase in print from our shop.

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Who's keeping track?

Reclaiming our digital privacy is more vital now than ever before

WE HAVE all been there. Aimlessly wandering around online when an ad for, say, the perfect pair of hiking boots pops up. Just in time for that long walk you have been planning. No surprise there, perhaps: we are used to our digital lives being tracked, sold and used to entice us with stuff. But these days – as you can read about in our feature on page 32 – the spookily accurate ads are just the tip of the iceberg when it comes to how much insight companies have about our lives.

The modern personal data business is an impenetrable tangle of cunning harvesting tricks, location tracking, collation, analysis, profiling, selling and reselling that is worth about £150 billion a year. We may be tempted to ignore or dismiss all of this, perhaps even to be thankful that

it at least makes ads relevant and often useful. But when that data could be used to judge whether we exercise regularly and eat healthily in order to price our health insurance, or to determine our personality style and therefore our suitability for a job, or even to track menstrual cycles to

“That data could be used to inform the government about potentially illegal abortions”

inform the police of potential illegal abortions, then surely we should be shocked out of our apathy.

The truth is that big technology companies thrive on timely data. After Apple changed the rules regarding how apps could track iPhone users in

2021, Facebook said the move would cost it around \$10 billion in 2022 alone. So action can still help to curb the problem.

The US will soon introduce privacy legislation that demands companies tell users when their data is being harvested. The EU is also working on new data privacy rules. Even China – where the state itself excels at online surveillance – has set strict rules on how companies can collect and use personal data.

We must play our part too by educating ourselves about which apps and websites are syphoning off information and considering whether that is an equitable trade-off for the services they provide. Because once our data is made available for sale, there is little limit to how others may decide to use it. ■

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Freeze squeeze

Strange springy ice may explain how clouds make rain **p9**

Quantum leap

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Zeroing in

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Planet undressed

Why has Neptune's cloak of clouds vanished? **p12**

Early night

Blackbirds go to bed sooner when they feel ill **p19**



Technology

Dancing robots steal the show

These AI-powered robots performed dance routines and somersaults at the 2023 World Robot Conference in Beijing, China. The Cloud Ginger devices, from Dataa Robotics, were just one of many hundreds of types of cutting-edge models on display at the show – which ran between 16 and 22 August – some of them disturbingly lifelike humanoids.

COSTA/PHOTO/SHUTTERSTOCK

Infectious diseases

Covid-19 antibodies give some immunity to SARS and MERS

Clare Wilson

AS A result of infection with the virus behind covid-19, and related vaccination campaigns, many people may have some immunity to other coronaviruses, including two that could cause dangerous outbreaks in the future.

This includes the virus behind SARS, which started spreading in China in 2002 and killed about 1 in 10 of those infected before the outbreak was stopped, as well as the deadlier virus behind MERS, which kills 1 in 3 infected people. Small outbreaks of MERS still occur when the virus crosses to people from camels.

“We were hoping that there would be [some antibody binding], but I wasn’t expecting to see so much,” says Florian Krammer at the Icahn School of Medicine at Mount Sinai, New York. “I’m happy to see it.”

Krammer and his colleagues took blood samples from 85 people in the US who had either received two or three doses of one of the mRNA-based vaccines against covid-19, had been infected with the SARS-CoV-2 virus, which can cause covid-19, or both. They compared these with 15 blood samples taken from people in the two years before the pandemic reached the US.

The blood was tested for antibodies against 21 coronaviruses, including three variants of SARS-CoV-2, the virus behind SARS, the one behind MERS and four that cause common cold-like symptoms.

The pre-pandemic blood samples generally had no antibodies that could bind to the coronaviruses tested, although some could bind to two cold-causing coronaviruses called OC43 and HKU1, as well as



CARMEN K. SISSON/CLOUDYBRIGHT/LALAMY

a virus that affects cows, which is thought to share a common ancestor with OC43.

The samples taken during the pandemic, however, had antibodies that bound to most of the 21 viruses to some degree (medRxiv, doi.org/kqft). This suggests a level of immunity that, while it might not prevent infection, would protect against severe illness and death, says

“A lot of us have circulating antibodies and immune memory that can cross-react”

Krammer. People may also have some protection against coronaviruses from their T-cells, the other main arm of the immune system, he says.

Being infected with a cold-causing coronavirus is thought to bring about immunity only to that virus, so it is unclear why infection with SARS-CoV-2, and covid-19 vaccines, generated broader immunity, says Krammer. “I think the pandemic changed a lot,” he says. “A lot of us have circulating antibodies

A covid-19 vaccine being given in Alabama during the pandemic

that cross-react and a lot of us have immune memory that can cross-react.”

Compared with other coronaviruses, the one behind covid-19 is “quite different”, says Paul Klennerman at the University of Oxford. The broader immunity from SARS-CoV-2 could be because many people had a more severe infection with it than they would with a cold-causing coronavirus, he says.

The findings don’t mean health authorities can stop preparing for the next pandemic, such as one caused by a relation of the viruses behind SARS or MERS, because a new coronavirus could still cause many deaths, says Krammer. A pandemic could also be triggered by something like bird flu jumping to people.

Nevertheless, the work might help in developing vaccines that protect against the whole coronavirus family, he says. ■

Space exploration

Russia’s Luna 25 moon mission ends in catastrophic crash

Matthew Sparkes

RUSSIA’S first moon mission in nearly half a century has ended in disaster as it smashed into the surface near the lunar south pole.

The Luna 25 mission was named in continuation of the Soviet Union’s missions of the 1970s, which ended with Luna 24 bringing samples of moon rock back to Earth in 1976. The new mission launched on 11 August atop a Soyuz-2.1b rocket from the Vostochny Cosmodrome in Russia and was due to put a lander in the Boguslawsky crater near the lunar south pole to study dust there.

On 20 August, the Russian space agency Roscosmos declared an “abnormal situation”, after what was intended to be a short engine firing to reposition the lander seemingly continued for too long, causing it to crash and “cease to exist”, the agency said in a statement on Telegram.

Roscosmos lost contact with the craft at about 2.57pm Moscow time on 19 August. The Russian Space Research Institute said in a statement that an official commission had been launched to determine the cause of the crash.

The mission had been seen as an effort by Russia to bring back the glory days of the Soviet Union’s lunar exploration, even as it became increasingly isolated due to its invasion of Ukraine. The European Space Agency (ESA) had been working with Russia on the mission, providing a camera for use during landing. But ESA ended the partnership after the invasion.

“When the partnership ended, ESA retrieved its hardware and has procured flight opportunities with other partners,” the agency says on its website.

India’s Chandrayaan-3 was due to land at the lunar south pole on 23 August as *New Scientist* went to press. This would make India the first nation to explore this region. ■

Fires wiped out megafauna

Blazes largely due to humans killed off large mammals in California 13,000 years ago

Michael Le Page

CATASTROPHIC fires were the immediate cause of the extinction of many large mammals in southern California 13,000 years ago, according to a study of fossils from the La Brea tar pits. The findings suggest these extreme fires were a result of humans changing the ecosystem by killing herbivores – meaning there was more vegetation to burn – and deliberately starting fires.

“It’s a synergy of the drying climate and the humans, and the fact that they are killing herbivores and increasing fuel loads, and all of those things go together to make a feedback loop that takes the ecosystem to a chaotic state,” says Robin O’Keefe at Marshall University in West Virginia. “The fire event is really catastrophic.”

The tar pits at La Brea in Los Angeles have trapped numerous animals over the past 50,000 years, preserving their bones.

O’Keefe and his colleagues have now used radiocarbon dating on 172 bones from eight species. Seven of these species are extinct, including the sabre-toothed cat (*Smilodon fatalis*), the dire wolf

(*Aenocyon dirus*), the western camel (*Camelops hesternus*) and the ancient bison (*Bison antiquus*). The team also dated coyote (*Canis latrans*) bones as a control.

The dating shows that the seven species were all gone from the La Brea area by 13,000 years ago, although some survived elsewhere in North America for another millennium or so. Their disappearance from La Brea

Models of mammoths at the La Brea tar pits, Los Angeles, where they once roamed



DAVID R. FRAZIER/PHOTOLIBRARY, INC./ALAMY

coincides with massive spikes in the number of charcoal particles in lake sediments, which are deposited during wildfires.

“Some of those spikes for those fires are just enormous, orders of magnitude more than has ever happened before,” says O’Keefe.

Pollen in lake sediments shows that the vegetation had begun changing from woodland to a more open landscape around 16,000 years ago, as the area became drier due to the retreat of the ice sheets. But there was a sudden shift to fire-resistant

vegetation about 13,000 years ago (*Science*, DOI: 10.1126/science.abo3594).

“The results of this study are consistent with humans increasing fire both directly through ignitions and indirectly through hunting of herbivores,” says Allison Karp at Yale University.

“It’s super relevant to today,” says O’Keefe, because more extreme wildfires are happening in many parts of the world due to climate change. “Hopefully, by learning these things about what happened at La Brea, maybe we can change our trajectory.”

Earlier research had suggested that the development of the Clovis stone tool technology, whose distinctive feature is finely crafted large spear points for tackling big animals, enabled people in North America to wipe out the continent’s megafauna. However, these findings show that some large mammals were dying out in places before Clovis tools appeared. O’Keefe and his colleagues think the tools were instead developed to tackle dangerous prey once easier targets had died off. ■

Physics

Strange springy ice may explain how clouds make rain

MOMENTS after supercooled water freezes, an odd kind of spring-like ice is born. The process, which has been glimpsed for the first time, could help explain how clouds make rain and affect Earth’s climate.

Clouds are made up of millions of water droplets at temperatures below freezing. These can exist as liquid until they are penetrated by an ice particle, which kick-starts a succession of freezing states. The

length and frequency of these states are crucial for models that simulate how clouds make rain and reflect light, but they happen so fast that they are hard to study.

Now, Claudiu Stan at Rutgers University-Newark in New Jersey and his colleagues have discovered a kind of ice that forms inside supercooled water droplets. It is both compressed and stretched at different points, like a spring in motion, microseconds after it first freezes. “It’s something that was definitely unexpected,” says Stan. “It took us a while to understand.”

To see the freezing process, the

researchers dropped a stream of water droplets through a vacuum, which cooled them to about -39°C (-38°F). They then used microscopy and X-rays to image thousands of droplets. They had only one image for each drop at a particular stage of freezing, but they could map out the process by looking at many images, a bit like a flipbook animation.

They found that each droplet turns into a slush ball, with a

“This odd kind of ice was definitely unexpected. It took us a while to understand”

network of ice permeating the liquid water, before freezing fully from the outside inward. This ratchets up the internal pressure, until the droplet either shatters or squirts out water, both of which result in ice particles that can freeze other droplets (*Nature*, doi.org/kqcs). This might help explain how and when droplets form ice in clouds that turns to rain.

The behaviour doesn’t fit our molecular-level understanding of ice, which could affect many fields, from food technology to climate science, says Stephen Cox at the University of Cambridge. ■

Alex Wilkins

Quantum computing

IBM makes error-correction leap

Chips that connect seven qubits could make correcting errors on quantum computers easier

Leah Crane

IBM has managed to dramatically reduce the number of quantum bits, or qubits, required to prevent errors in a quantum computer. Its latest approach to quantum error correction should bring down the number of qubits needed to build a useful quantum machine.

The biggest problem with today's quantum computers is that they are noisy, meaning they have error rates around 1 in 1000, whereas classical error rates tend to be around 1 in 1 billion billion.

To lower the error rate, you need extra qubits – potentially millions or more – to check for errors and make sure that your final answer is accurate.

"The overall principle of error correction is redundancy," says Ted Yoder at IBM in New York. "If I really want to send you a message and make sure you get it, one thing I can do is send it multiple times, and even if there's a bunch of noise around, hopefully you get every part of it."

But with today's technology, it isn't possible to build and connect that many qubits. So Yoder and his colleagues have come up with a

procedure that can correct errors while reducing the number of qubits required to keep errors low.

Their protocol is based on a set-up in which each qubit in the computer is connected to six others via quantum entanglement, so each of the seven connected qubits monitors the others.

The main front-runner in quantum error correction, called the surface code, connects each

Quantum computers, such as the IBM Quantum System One, have high error rates

qubit to four others, making it easy to arrange them in a simple grid on the surface of a chip, but the new set-up requires two parallel grids to achieve the required level of connectivity.

This would require new types of chips and long-range connectors between the qubits, but it could reduce the number of qubits required to store information in a quantum computer by a factor of 10. The researchers say it could achieve a level of error correction with 288 qubits that would require 4000 qubits using the surface

code (arXiv, doi.org/kqc6).

The technologies required to do this could be built within the next couple of years, says Jérémie Guillaud at French quantum computing start-up Alice & Bob.

We aren't on the verge of faultless quantum computing just yet, though. "Fault tolerance is so hard to achieve because implementing error correction alone is not enough," says Guillaud. "The quantum systems actually need to be very good to start with for quantum error correction to work."

As long as the original qubits have error rates below 0.8 per cent, this new system is expected to improve error correction dramatically. "Otherwise you're building a house out of crumbling bricks," says Yoder. An error rate below 0.8 per cent isn't unreasonable in the near term.

The system would also require hundreds of qubits, whereas most current quantum computers have fewer than a hundred. "There are still hurdles to overcome, but we are excited about the direction that this opens up," says Yoder. ■



MISHA FRIEDMAN/GETTY IMAGES

Neuroscience

Consciousness traced to specific nerve cell clusters

A MAP of brain structures involved in keeping us awake could one day help to improve people's recovery following surgery or comas.

Consciousness has two major components: wakefulness and awareness. Many researchers have mapped the connections between nerves in the outer layer, or cortex, of the human brain that underpin awareness, but the anatomical basis of wakefulness – which is

regulated deeper inside the brain – was less clear.

Now, Brian Edlow at Harvard Medical School and his colleagues have mapped how 18 clusters of nerve cells, or neurons, known to underlie wakefulness in mice, rats and cats connect to each other in deep regions of the human brain.

The researchers took magnetic resonance imaging scans of the brains of three women after they had died at about 60 years old. This showed how 10 clusters of neurons in a region at the base of the brain, the brainstem, connect to six clusters in central brain

structures called the thalamus and hypothalamus. The map also revealed how these clusters – previously associated with wakefulness – link to two other clusters in a region in the front of the brain called the basal forebrain.

Next, the team traced how these neural clusters connected with outer regions of the brain known to regulate awareness. By combining these findings with brain activity

"This could revolutionise our understanding of awareness and consciousness"

data collected from 84 awake people, the team mapped how electrical signals travel between the 18 clusters (bioRxiv, doi.org/kqcz).

The findings could "revolutionise our understanding of awareness, human consciousness and a range of neurological and psychiatric conditions", says Emmanuel Stamatakis at the University of Cambridge.

The map could also help us understand coma or confusion after surgery, opening the door to treatments, says Luis de Lecea at Stanford University in California. ■
Carissa Wong

Technology

3D-printed toilet is so slippery nothing can leave a mark

Alex Wilkins

A 3D-PRINTED toilet is so slippery that almost nothing can stick to it, which could massively reduce the amount of water used for flushing.

There are many kinds of slippery toilet surfaces, like Teflon-coated bowls, but the more they are used, the less slippery they become. This means the coating or toilet needs to be replaced to remain effective.

Now, Yike Li at Huazhong University of Science and Technology in Wuhan, China, and his colleagues have developed a toilet that is extremely slippery and remains so in the face of abrasion.

Li and his team made a model of the toilet, about a tenth of the size of a standard one, by 3D printing a mix of plastic and hydrophobic, or water-repelling, sand grains, using a laser to fuse the particles together, creating a complex structure.

They then lubricated the bowl with a silicon oil, which penetrated below the surface of the material.

The researchers threw muddy water, milk, yogurt, honey and synthetic faeces into the toilet, and none of them stuck. The surface stayed as slippery even after being rubbed with sandpaper more than 1000 times (*Advanced Engineering Materials*, doi.org/kqdd).

The toilet would need less water to run than a standard one, says Li. But it needs to be tested at full size and made cheaply, he adds. ■

Dyed honey was used to test the slipperiness of a miniature 3D-printed toilet

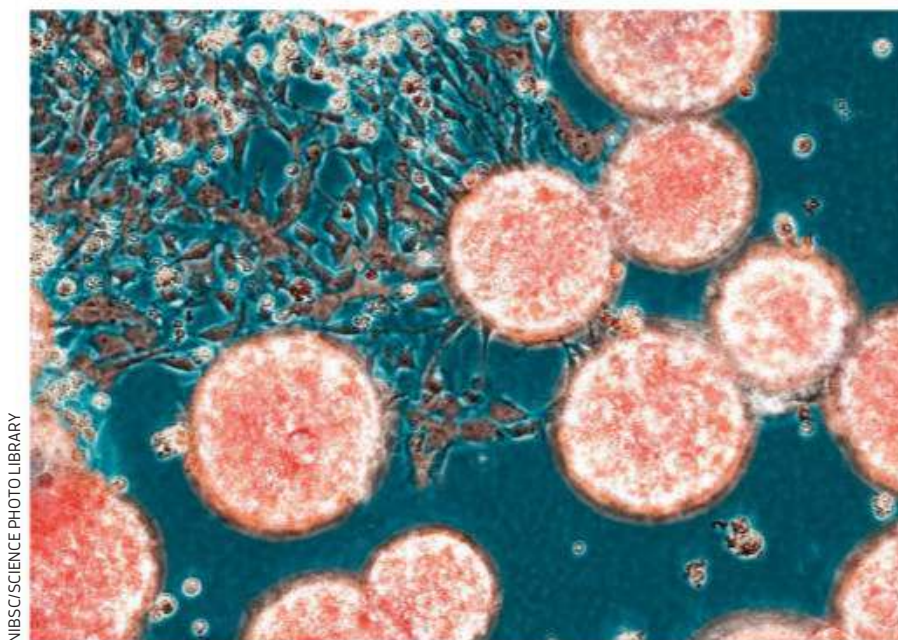


BINSU ET AL. (2023)

Biotechnology

Wiping stem cells 'clean' could make them easier to produce

Jason Arunn Murugesu



Stem cells beginning to transform into another type of cell

into new cell types that don't have these anomalies.

They first induced the human cells to become stem cells in the typical way, culturing them for seven days. Then they transferred the cells into a second culture medium containing chemicals designed to make the stem cells more closely resemble those found in an embryo pre-implantation. After five days in this second culture medium, the researchers returned the cells to the original culture medium type for just over two weeks.

The five-day transfer removes most of the residual DNA markers, says Lister. "In this way, we mimic the natural process of how the epigenome resets in the early embryo," he says.

Lister and his colleagues also compared stem cells produced in this new way, which they called the transient naive treatment, with those made in the typical way, by inducing them to become various types of adult cell such as neurons and those in skeletal muscle.

The researchers found that their method led to a higher successful conversion rate than the typical method (*Nature*, doi.org/kqdc).

Joseph Wu at Stanford University in California says this new method could lead to more effective and safer therapeutic interventions using induced stem cells. "These findings are a significant step towards harnessing induced pluripotent stem cells' potential for various scientific and clinical purposes," says Wu. ■

A NEW way to turn adult human cells into ultra-flexible stem cells could make it easier to produce them in large quantities and make them more effective at treating disease.

Stem cells can develop into any of the types of cell in our bodies. People have long hoped to exploit this ability by programming stem cells to turn into a specific cell type to be used in treatments.

Acquiring stem cells can be difficult. One method is to take them from embryos before they implant into the uterus, but doing this is controversial. Instead, researchers can use a bath of chemicals to make adult human cells reprogram themselves back into a type of stem cell known as an induced pluripotent stem cell, which can then be turned into the desired type of cell.

This method isn't a complete reprogramming, though, says Ryan Lister at the University of Western Australia. Some newly induced stem cells retain residual DNA markers of their original adult cell form, he says.

These markers can make it harder to convert induced stem

cells into new types of cells and can cause resulting cells to act in undesired ways, says Lister.

Such issues don't occur in stem cells that are taken from embryos. This is because there is a phase early in human development when

"We mimic the natural process of how the epigenome resets in the early embryo"

the chemical modifications of DNA – also known as the epigenome – from the sperm and egg are reset and erased, says Lister. "It essentially wipes the slate clean," he says.

While we already know how to induce adult cells into stem cells that resemble those found in pre-implantation embryos, existing methods can't do it at scale and are still haunted by the problem of anomalous cell behaviour, says Lister.

Now, Lister and his colleagues think they have come up with a method that creates induced stem cells that have fewer residual DNA markers from their original cell state and can be easily cultured and turned

Solar system

Neptune's clouds have vanished

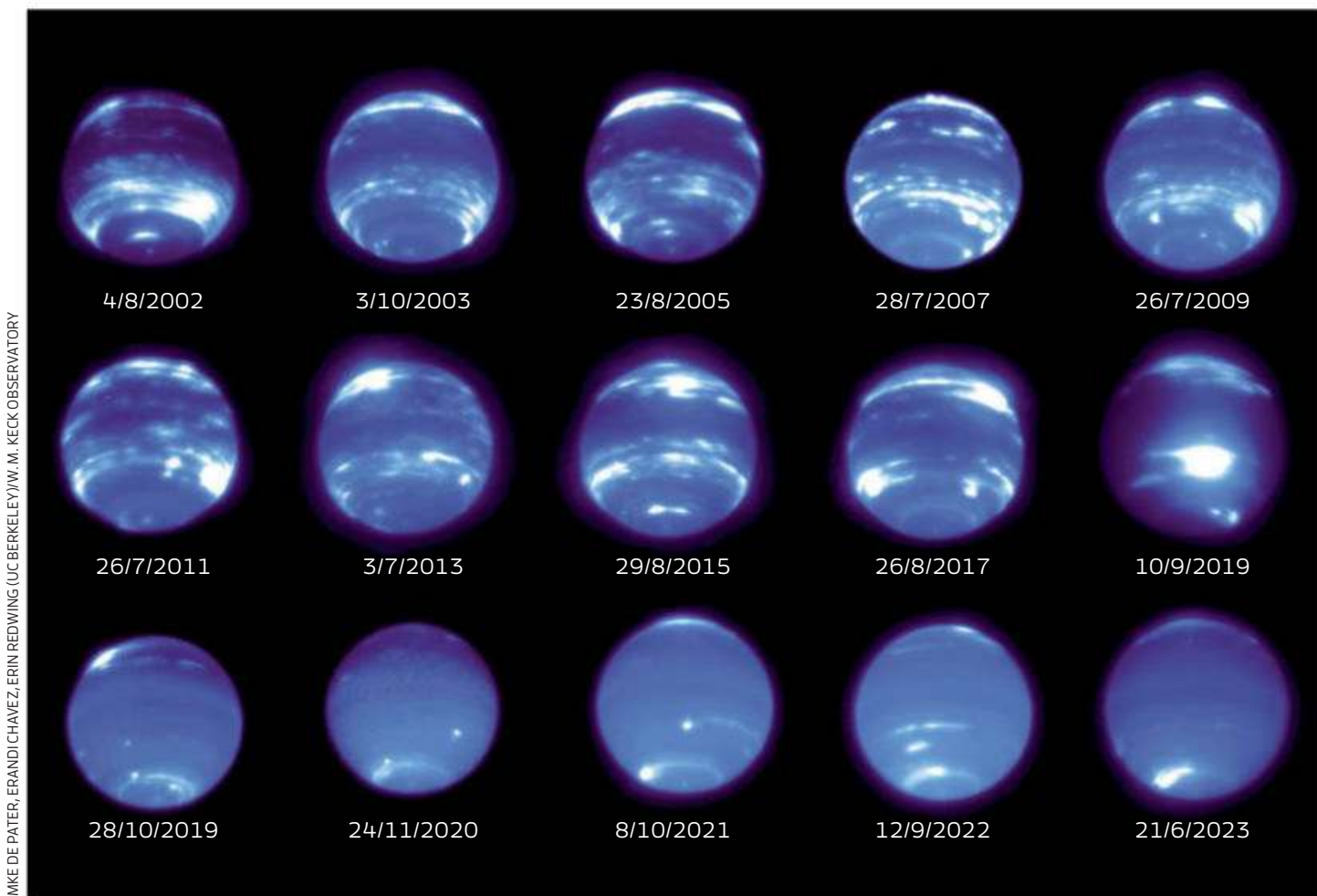
The sun's activity may have stripped away the clouds that usually shroud Neptune

Leah Crane

THE clouds that usually encircle Neptune have disappeared. When the first detailed images of the planet were taken by the Voyager 2 spacecraft in 1989, its cerulean disc was criss-crossed by clouds, but its skies are now almost clear.

Erandi Chavez at the University of California, Berkeley, and her colleagues have tracked Neptune's cloud cover from 1994 to 2022 using images from ground-based observatories and the Hubble space telescope. They have found that the amount of clouds fluctuates roughly in line with the sun's 11-year cycle of activity, albeit with a two-year lag. When the sun is most active, more clouds begin to form, and when it is least active, the clouds dissipate (*Icarus*, doi.org/gsmhms).

This may happen because when sunlight hits Neptune's atmosphere, its energy starts chemical reactions. Those reactions take time, hence the two-year delay. ■



IMKE DE PATER, ERANDI CHAVEZ, ERIN REDWING (UC BERKELEY)/W. M. KECK OBSERVATORY

Mind

Negative emotions really do make time drag

PEOPLE often feel time drag on or fly by, but now there is evidence that our emotional state influences our perception of time passing.

To investigate the phenomenon, Jingyi Wang and Regina Lapate at the University of California, Santa Barbara, asked 80 volunteers to look at pictures of things that either typically induce a negative emotion, such as a coffin, or are neutral, such as a table. The images were shown for 4 seconds, with a 2.5-second gap between them. A grouping of four consecutive negative or neutral pictures constituted an "event".

Between these events, the researchers would either switch the emotion, the colour of the

pictures' borders or both. This was to simulate how life experiences can differ in terms of perceptual details or emotional content.

Wang and Lapate periodically assessed the participants' perception of the time interval between pairs of images they had seen, getting them to indicate this on a slider marked with "very far", "far", "close" and "very close".

The image pairs were always two that had appeared consecutively, but sometimes they were within the same event and at other times they were the fourth image of one event and the first of the next.

When gauging the distance between neutral to negative images from across two events,

the participants judged it as longer. However, participants perceived pairs of negative images from within the same event as being closer together than neutral pairs (bioRxiv, doi.org/kpxc).

"People who generally view things negatively tended to report time passing more slowly"

The researchers used questionnaires to assess people's tendency to view things negatively. Those whose scores indicated a more negative outlook generally reported time passing more slowly during neutral-to-negative switches. "Dwelling on

negative events is associated with anxiety and depression," says Carien Van Reekum at the University of Reading, UK.

This research could one day be useful as an objective warning sign of such conditions, says Wang.

The study didn't include images that induce positive reactions, so it isn't clear if the time-perception changes were due to negative emotions specifically or emotion generally. The researchers are now studying what happens after a positive event and investigating if measures of emotional arousal, such as facial movements, can account for different reactions to the same picture. ■

Simon Makin

Animal behaviour

Flies seem to enjoy going for a ride on a spinning carousel

Chen Ly

SOME fruit flies seem to choose to whizz around on a carousel in what may be a form of play.

Many animals, such as dogs and gorillas, play, but it is unclear how common such behaviour is in insects and other invertebrates. Last year, researchers found the first evidence of insect play: bumblebees rolling wooden balls around.

Tilman Triphan and Wolf Huetteroth at the University of Leipzig in Germany have now found that fruit flies (*Drosophila melanogaster*) seem to play too.

The pair built small arenas with access to a spinning carousel and some food. They placed 112 flies in the arenas, with each one housing one fly at a time for three to four days each. Another 194 flies were placed in the same environment, but with a stationary carousel, as a comparison group.

The flies that had access to the spinning carousel tended to spend upwards of 5 minutes on it at a time – more than those for whom the carousel didn't move. Many flies visited the spinning carousel several times over the course of the experiment (bioRxiv, doi.org/kqcw).

"We were all astonished," says Huetteroth. "My expectation was that the flies would completely avoid it and wouldn't like it at all."

To be considered play-like behaviour, an activity must have no immediate relevance for survival, and must be voluntary and intentional. So these findings do suggest that fruit flies engage in play, says Huetteroth.

Triphan and Huetteroth also found that some flies seemed to seek out the spinning ride more than others, and some avoided it.

"The study is quite well designed to make a convincing case that flies will voluntarily seek the opportunity to experience whizzing around," says Sergio Pellis at the University of Lethbridge in Canada. ■

Technology

Google AI predicts floods four days in advance in Africa

Alex Wilkins

GOOGLE'S artificial intelligence flood prediction system can now forecast floods at least four days in advance in data-poor regions, like Africa and South America, as well as it can in data-rich areas like Europe and the US.

Most of the world's waterways don't have accurate measurements for water flow, which makes predicting floods hard. Lower-income countries are disproportionately affected by a lack of data, whereas

countries covered and helped alert people living there to possible floods.

Now, Grey Nearing at Google and his colleagues have tested their AI prediction system on data from more countries around the world.

To develop the AI model, Nearing and his colleagues fed it publicly available stream flow data gathered by the World Meteorological Organization, as well as ground and satellite-based weather forecasts from up to a year before. The model worked out the relationship between these variables and water levels from real bodies of water. It could then use this to predict future events when given new data.

"One of the limitations of traditional hydrology models is that they're really accurate mostly in places where they're well calibrated," says Nearing. "AI models, even though they're data driven, learn general hydrological behaviours and

Floods, like this one in Madagascar in 2022, can cause devastation

are better able to move from one location to another."

The researchers tested their model on more than 5000 water flow measurements from across the world, taken between 1984 and 2021, and found that, on average, the system could predict flooding events between four and six days in advance in regions with sparse water data, such as in Africa and South America, and sometimes as far ahead as seven days. The researchers assessed the flood predictions at the continent level rather than at the country level (arXiv, doi.org/kqcw). This matches what the model could already do in regions with plenty of data.

These predictions were as accurate four days in advance as the best conventional systems can predict on the day. "If you go to our Flood Hub and you look at the predictions four days from now, you're gonna get information that's about as accurate as you would have gotten from the existing system if you went and looked for today," says Nearing.

While the data in the study was restricted to publicly available information, Google currently has data for more than 80 countries available in its Flood Hub and Google Search. "Anyone can go and look. And if you're in an area that we cover, then you'll see the information from this model in real time," says Nearing. The system has been operational and sending out flood alerts in 80 countries since October 2022.

"The fact that this improves on our current global benchmarks is really significant for disaster forecasting," says Paul Bates at the University of Bristol, UK. ■

80

Number of countries covered in Google's Flood Hub site

higher-income countries are more likely to have well-measured rivers and lakes and so more accurate predictions.

In 2018, Google introduced an AI-powered flood forecasting system for India and Bangladesh, two of the most flood prone countries in the world. It later expanded the number of countries available and launched a website, called Flood Hub. The system had high predictive power for the few



Artificial intelligence

AI developers feel chip squeeze

The high-powered chips required for training the most advanced AIs are in short supply, creating winners and losers, reports **Matthew Sparkes**

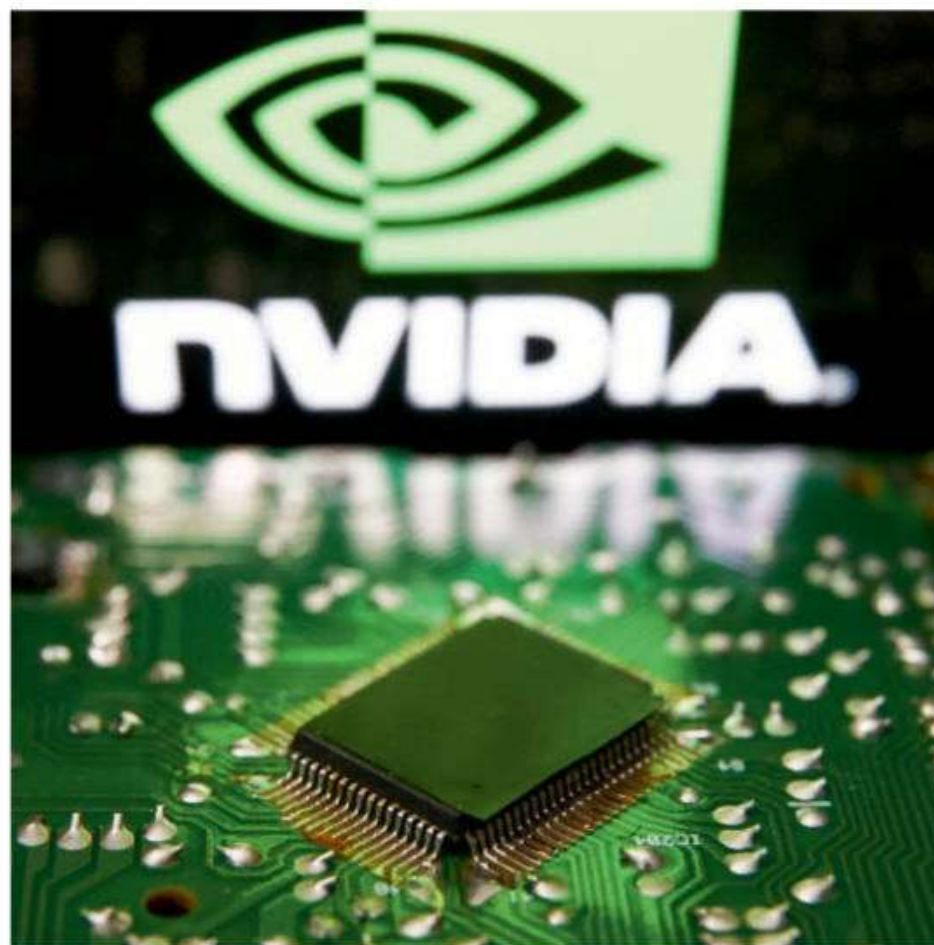
IN THE AI gold rush, chip-makers are selling shovels – and they are in short supply. As the latest generation of artificial intelligence models like ChatGPT look set to transform our lives, the hardware that makes it all possible is becoming a strategic asset, with countries, companies and researchers all scrabbling to get hold of supplies. With talk of shortages lasting until at least next year, some would-be AI developers face being left behind.

At the centre of this is Nvidia, which joined the small clique of trillion dollar companies earlier this year, sitting alongside the likes of Apple and Google owner Alphabet. Nvidia, based in California, made its name creating hardware to run computer games, but these graphics processing units (GPUs) turned out to be extremely capable at churning through the vast amounts of data required to train an AI. Reports suggest that Nvidia now controls 80 per cent of the world's GPU market.

But there are signs that this huge demand is leading to supply issues and creating a bottleneck for those wanting to get their hands on Nvidia's most powerful AI GPUs, the H100 and A100. This is a predictable result of the current AI boom, with recent advances being closely linked to scale and therefore the number of GPUs you have.

The company hasn't confirmed a shortage and declined an interview with *New Scientist*, but rumours suggest any new orders are unlikely to be fulfilled until 2024 – a huge stretch of time when it comes to the pace of AI development.

"NVIDIA allegedly has sold out its whole supply through the year," tweeted Suhail Doshi, founder of AI image creator



Nvidia is the world's leading manufacturer of graphics processing units

\$1bn

Reported spend on graphics processing units (GPUs) by TikTok owner ByteDance in 2023

80%

Nvidia's reported share of the global GPU market

2024

New Nvidia orders placed today won't be fulfilled until next year, rumours suggest

Playground AI, on 25 July in response to conversations he said he has had with vendors. "I'd forecast a minimum spend of \$10m+ to play right now if you can even get GPUs."

On top of this seeming shortage, AI teams in China are feeling the bite of US restrictions that came into force in September last year. The US has banned exports of high-end GPUs, like the H100, to Russia and China in order to prevent them being used for military applications.

Nvidia has attempted to skirt this export ban by developing versions of the chips with reduced data transfer rates that comply with the ban, and is seeing healthy sales. TikTok owner ByteDance has reportedly ordered around \$1 billion worth of Nvidia GPUs so far this year, perhaps aiming to get ahead of any further tightening of the rules by the Biden administration. ByteDance didn't

respond to a request for comment.

Meanwhile, other Chinese firms are suffering. Tech giant Alibaba recently told investors it had been unable to meet customer demand for training AIs due to a shortage of GPUs.

"The hype around machine learning has led to a lot of competition for kit and brains"

Worst hit by the global GPU shortage is academia, given its limited research budgets. "The hype around machine learning has led to a lot of competition for kit and brains," says Tobias Weinzierl at Durham University, UK. "Even if we order [GPUs], we don't get kit in a timely fashion." Meanwhile, higher salaries and better access to resources are tempting many academic researchers to leave for the private sector, says Mhairi Aitken at the Alan Turing Institute in London.

Dhiya Al-Jumeily at Liverpool John Moores University, UK, says that industry is taking AI ideas, architectures and research from academia and applying massive scale – which university budgets can't stretch to – to leverage better results. What is needed, he says, is more collaboration – to bring together the experience and talent of academia with the budgets and experience of commercialisation from big tech companies.

"Companies look for money, they don't care about human development. As academics, we work hard to serve human beings," says Al-Jumeily. "Whatever AI has reached now, it's because of academia. Without our research, they cannot push those boundaries."

Paolo Remagnino, also at Durham University, says that tech companies working on

exceedingly large data-driven AI models, equipped with vast amounts of hardware, are leaving academic researchers behind.

“Companies can exploit extremely large corpora of data [that] we will never be able to host or handle given our limited storage capabilities,” he says. “On top of that, large corporations now actively involved in applied and more theoretical research have stormed into the international conference and scientific journal landscape, making it very hard for small academic institutions to compete.”

Mahesh Balasubramanian at chip-maker AMD says that academics can apply for grants to get GPUs, or buy time on cloud-based services, but concedes that the costs can rise quickly. He says he is seeing a trend for some researchers to focus on smaller AI models that are trained to do specific tasks, leaving research on the gigantic models that require computing hardware worth millions to the big technology companies. “That’s a lot more economical,” he says.

Fine-tuned model

The other approach academics are taking is to focus on a different part of the process of training an AI model. The biggest AI systems are built from scratch using huge datasets to create software that has broad abilities. Then a fine-tuning stage occurs to tweak the model and hone its abilities on a single task. This stage uses a smaller but more focused dataset and needs fewer computing resources.

“For researchers that may

not have many GPU resources, they can still do many things in the fine-tuning stage and they can try to improve this work or improve this field,” says Tan Wang at Nanyang Technological University in Singapore.

One issue with this approach is that the researchers often don’t have full details of how the model was trained and what data was used, making it harder to carry out open and repeatable science.

Can anything be done to increase the supply of chips for AI? Numerous companies are racing to launch their own GPUs to rival Nvidia, while tech giants like Google, Amazon, Microsoft and Meta are turning to custom chips to run their own AI tools as efficiently as possible.

But switching chips isn’t easy. Nvidia’s GPUs utilise proprietary software called CUDA that squeezes the most out of them when applied to AI-related tasks, and this isn’t available on chips made by the likes of Intel and AMD.

George Hotz, the founder of AI company Comma, said in a recent video posted to YouTube that he is “giving up on AMD” after encountering problems trying to write and run custom AI software on the company’s GPUs. James



SUNDY PHOTOGRAPHY/ALAMY

Rival chip-maker AMD hopes to tempt over Nvidia customers

Knight at the University of Sussex, UK, says that Hotz’s complaint was a “version of the experience everyone who has tried to use AMD hardware has suffered”.

Balasubramanian says it is true that some users have found problems making the switch from Nvidia to AMD because the platforms are slightly different. This can be solved, he says, if developers invest more time learning the new environment.

“People who have gotten into the CUDA ecosystem early, for them it is this system of familiarity. And the expectation is everyone

matches that familiarity,” says Balasubramanian. “It requires a little extra tweaking because, at the end of the day, the architecture for Nvidia and AMD are not the same.”

That said, there are software tools available to help make switching between chips a smoother experience. If researchers build their AI using software such as PyTorch (originally developed by Meta) or TensorFlow (originally created by Google) they can theoretically switch from Nvidia GPUs to AMD GPUs with minimal upheaval. This means they can change their supplier based on performance, cost or supply chain issues – a benefit also enjoyed by the likes of Meta and Google.

“That’s what these big AI players want,” says Balasubramanian. “And that’s part of the reason why they developed this – they want to make sure that they’re not locked into a single [GPU] vendor.”

“Large corporations have stormed into AI research, making it hard for small institutions to compete”

There are other positive signs, too. Supply chain problems during the covid-19 pandemic are resolving, the race to buy hardware to capitalise on a new trend is slowing down and the number of GPU manufacturers is expanding. New entrants are working to catch up and the market is widening, while existing players step up production.

Ultimately, if advanced AI models are going to be fully integrated into society, we need a wide range of people, from academics to activists, to be able to explore and interrogate them. Only then will the wealth of the AI gold rush be shared by all, rather than be limited to a few firms. ■



ALEX BRANDON/ASSOCIATED PRESS/ALAMY

The US and China are in a face-off over access to high-powered AI chips

Medicine

Pig kidney transplant success

A kidney transplanted into a brain-dead man on life support was still functioning 32 days later

Grace Wade

A GENETICALLY modified pig kidney transplanted into a recently deceased person kept on life support has been functioning for more than a month without signs of rejection or infection. The achievement, announced on 16 August by researchers at NYU Langone Health in New York, marks the longest a pig kidney has functioned inside a human. As such, it is a promising step in xenotransplantation, the transfer of animal organs to humans.

This is the fifth pig-to-human kidney transplant to be performed, all of which have occurred in people declared brain-dead and then maintained on life support. On 14 July, Robert Montgomery at NYU Langone Health and his colleagues transplanted a pig kidney into Maurice Miller, a 57-year-old man who had been declared brain-dead after complications from a brain tumour biopsy. Miller's family agreed to the experimental procedure after learning he had an aggressive brain cancer that prevented him from donating his organs. He is being kept on life

support until the study concludes.

The kidney came from a pig bred to lack a gene that produces a carbohydrate called alpha-gal. This carbohydrate isn't found in humans and causes our immune system to reject, or attack, organs from other animals. To further reduce the risk of rejection, the researchers transplanted the pig's thymus – a gland that helps the immune system differentiate

A genetically engineered pig kidney arrives ready for transplant into Maurice Miller

between the self and foreign cells – into Miller and gave him immune-suppressing medications.

Immediately after the transplant, the kidney began producing urine. For 32 days, Miller's blood levels of creatinine – a waste product cleared by the kidneys – remained in the normal range, indicating proper kidney function. Biopsies of the organ have found no signs of rejection.

After the death last year of David Bennett – the first person to receive a genetically modified pig heart – there are concerns about

xenotransplantation transmitting viruses to humans. Bennett died two months after the procedure, potentially because of a pig virus called porcine cytomegalovirus.

Montgomery and his team have been using a more sensitive test to look for viruses than the one used for Bennett. So far, they haven't found any sign of infection.

They plan on monitoring the kidney for another month before ending the study. That means they will have passed the critical two-month period when most non-human primates reject organs from pigs, said Montgomery during a press conference.

We have a lot of information from non-human primate studies on xenotransplantation but didn't know how translatable this was to humans, he said. "This two-month study period, I think, will check a lot of the boxes we need to move into early clinical trials."

Xenotransplantation is a possible solution to the shortage of organ donors. In the US, more than 100,000 people are waiting for an organ transplant, and 17 of them die each day. ■



JOE CARROTT/NYU LANGONE HEALTH

Artificial intelligence

Multilingual AIs are better at responding to queries in English

LARGE language models (LLMs) that are designed to respond to queries in multiple languages seem to work better if asked to translate the request into English first.

LLMs have become a key part of the artificial intelligence revolution since the release of ChatGPT by OpenAI in November 2022. But interacting with them is primarily done in English. Some developers have tried to overcome this issue

with multilingual models. These are trained on multiple languages at once, allowing them to make links between languages with a large amount of training data and those with less.

Julen Etxaniz at the University of the Basque Country in Spain and his colleagues compared two methods for putting non-English language inputs into multilingual LLMs and getting a response.

The first simply involves putting the query in its original language into the LLM and getting a response in the language. The second entails asking the same model to translate

the query from the original language into English, then posing the translated question to the LLM, before getting a response in English.

The researchers tested seven LLMs, including the first version of LLaMA, Meta's AI language model. For all seven, the second approach produced results that were between 0.3 and 3.5 percentage points more accurate than those from the first method (arXiv, doi.org/kpv8).

"There's a lot of work to do to make multilingual language models really multilingual"

Using LLMs to translate into English first won't be practical for tasks like content moderation because machine-translating text can contain errors and terms that language speakers don't use, says Aliya Bhatia at the Centre for Democracy & Technology in the US.

AI has a language representation problem, partly because the main language spoken on the internet – a major source of training data for AI models – is English.

"There's a lot of work to do to make multilingual language models really multilingual," says Etxaniz. ■
Chris Stokel-Walker

Food science

Gene-edited yeast makes rice wine taste like bananas

Karmela Padavic-Callaghan

BY EDITING yeast genomes, we can make bread that rises higher, potato crisps that contain fewer potential carcinogens and rice wine that tastes like bananas.

The fermentation process caused by yeasts has been used in baking and brewing for millennia and there are yeast strains that work better in specific applications.

Yong-Su Jin at the University of Illinois Urbana-Champaign and his colleagues have now used CRISPR gene editing to modify the *Saccharomyces cerevisiae* yeast, which is commonly used in the food industry. The team edited the yeast's genome so that it turned more sugar into carbon dioxide rather than alcohol, Jin told attendees of the American Chemical Society meeting in San Francisco on 14 August. Bread made with this gene-edited yeast had an 18 per cent larger volume than bread made with conventional yeast.

Jin and his colleagues also altered a gene in another yeast strain used to make crisps from fermented potato dough. Crisps made with this yeast had up to 78 per times lower levels of a potentially carcinogenic chemical called acrylamide.



Illustration of yeast, which can be genetically modified to transform foods

The team also manipulated yeast to alter the flavour of a Korean rice wine called makgeolli. Engineering yeast to produce more amino acids during fermentation led to makgeolli with a stronger savoury, umami flavour. And another yeast engineered to make more molecules called esters produced a wine that had a banana-like flavour. ■

Space

Aliens on low-oxygen worlds may never discover fire

Alex Wilkins



YURIY MAZUR/SHUTTERSTOCK

LIFE on a planet with low levels of oxygen might never be able to develop technology because combustion would be impossible. This bottleneck for creating advanced civilisations may also help explain why we have yet to observe life elsewhere in the universe.

The development of more sophisticated technology on Earth hinged on fire, also known as combustion, a chemical reaction that uses oxygen to generate large amounts of heat.

This is crucial for extracting metals from ore, say, which almost all advanced human technology relies on. Lab experiments have found that combustion can't fully occur in atmospheres with oxygen levels below about 18 per cent.

Now, Adam Frank at the University of Rochester in New York and Amedeo Balbi at the University of Rome in Italy suggest that this might be a bottleneck for whether alien species can develop technology.

"You may have enough oxygen in the atmosphere of an exoplanet to have complex multicellular life, but you may

not have enough oxygen to start combustion," says Balbi.

We don't know the exact balance of geological and biological processes that lead to an atmosphere with this level of oxygen because we only have Earth as an example. "Oxygen in the atmosphere is also produced

18%

Amount of oxygen needed in atmosphere for full combustion

by photosynthetic activity, so that's why it gets complicated, because it's not just geology, it's also biology," says Balbi.

There is also an upper limit to a useful amount of oxygen. At about 30 per cent and above, depending on the air's moisture content, the chance of widespread fire killing life forms would become high as combustion becomes so easy, says Frank. Astronomers are looking for any type of life in the universe, but the search for advanced aliens might be guided by seeking planets with atmospheres that are between 18.5 and 21 per cent oxygen, the

Some planets could host complex life, but nothing will burn there

optimum for useful combustion (arXiv, doi.org/kptb).

For now, though, detecting atmospheric oxygen is beyond the abilities of our telescopes for almost all known exoplanets. "We're just getting started looking for the atmospheres of terrestrial planets," says Frank. "This is the exciting thing – we're at the frontier now."

Combustion as a bottleneck for technology makes sense if life emerges how it did on Earth, but might not apply if life elsewhere evolved differently, says Ingo Waldmann at Imperial College London. "That was the evolutionary path we took, but I'm not necessarily sure whether that can be generalised across the universe."

For instance, it is possible that an alien species in a low-oxygen environment could harness heat from geothermal activity, such as volcanoes, to do their smelting, says Waldmann.

Such alternatives aren't portable like wood and fossil fuels, says Balbi, which may mean any civilisations would need to stay close to the heat.

If the oxygen bottleneck is a limiting factor, say Frank and Balbi, it might help solve the Fermi paradox, which questions why there are no signs of advanced intelligent alien life if it is apparently likely, given the size of the universe.

"The Fermi paradox is telling us something about the nature of life in the universe that we don't understand," says Ian Crawford at Birkbeck, University of London. "In that context, all potential solutions to the Fermi Paradox are of interest." ■

Palaeogenomics

Ötzi the iceman may have been bald

Reanalysing the genome of Ötzi, who lived 5300 years ago and whose mummified body was found in the Alps, has changed the story of where his ancestors came from, finds **Michael Marshall**

A NEW genetic analysis has changed our understanding of Ötzi, the mummified “Iceman” who lived 5300 years ago and was found in a glacier in the Alps.

The findings reveal that almost all of Ötzi’s DNA was inherited from early farmers, who moved into Europe a few thousand years before he was born. The genome also indicates that he had darker skin than any people with predominantly European ancestry today, and may well have been bald.

Ötzi’s mummified body was discovered in 1991, thawing out of an Alpine glacier near the border of Austria and Italy. He is estimated to have lived sometime between 3350 and 3120 BC. The remains have been studied for more than 30 years, revealing, among other things, that he had a wound from an arrow, suggesting he was murdered.

Weird finding

In 2012, a draft of Ötzi’s genome was published. It suggested he had ancestry from three different groups: hunter-gatherers who first moved into Europe around 40,000 years ago, early farmers who arrived from the Middle East

“The light skin pigmentation that many Europeans have today is a very recent phenomenon”

around 9000 years ago and people from the Eurasian steppe who arrived less than 5000 years ago.

“That was always weird,” says Johannes Krause at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. That’s because the steppe peoples didn’t arrive in Europe until after Ötzi died, so it didn’t make sense that he had

steppe DNA. Many geneticists suspected that the genome had been contaminated with modern European DNA, which contains steppe DNA.

To find out, Krause and his colleagues have re-sequenced Ötzi’s genome using modern

MPL/REVOLUTIONARY ANTHROPOLOGY



An illustration of what Ötzi might really have looked like

techniques. The new genome is much more accurate and shows no sign of steppe ancestry.

“There was almost 10 per cent contamination in the old dataset,” says Krause. Albert Zink at Eurac Research in Bolzano, Italy, who worked on both the 2012 study and the new one, agrees that there was some human contamination in the original genome.

It turns out that about 90 per cent of Ötzi’s ancestry came from the Middle Eastern farmers,

with the remainder from the hunter-gatherers. This is unusual: most people living in Europe at that time had a more mixed ancestry, because the incoming farmers interbred with the hunter-gatherers.

“Now he’s an outlier in another way,” says Krause. “He has a lot of early farmer ancestry, more than anyone else from this time period.” It could be that Ötzi himself was unusual in this way, or that his population didn’t mix much with hunter-gatherers when they entered Europe – perhaps because they lived in relatively remote areas of the Alps.

The new genome reveals a gene variant that is associated with a higher risk of male pattern baldness. This makes sense, says Krause, because very little hair was preserved with Ötzi. “He was in his late 40s so I think it’s possible [he was bald],” he says.

Krause and his team also identified 154 sites in the

The mummified body of Ötzi, who lived between about 3350 and 3120 BC



ANDREA SOLERO/AFP VIA GETTY IMAGES

genome that have been associated with skin pigmentation in modern populations. The sequences they found suggest that Ötzi’s skin was darker than that of people with predominantly European ancestry living today, although not as dark as that of people from sub-Saharan Africa (*Cell Genomics*, doi.org/gsmndnt).

This fits with an emerging body of evidence about prehistoric Europeans, says Alissa Mittnik, also at the Max Planck Institute for Evolutionary Anthropology, who wasn’t involved in the study.

Vitamin D deficiency

“The hunter-gatherers most likely had even darker skin, and also probably the early farmers would have had darker skin than what we know from Europe today,” says Mittnik.

“The light pigmentation Europeans have today is a very recent phenomenon,” says Krause. It “really only was established as light as it is today about 4000 years ago”.

Compared with hunter-gatherers, farmers ate less meat and fish, putting them at risk of vitamin D deficiency; losing their skin pigmentation enabled them to synthesise more vitamin D in their skin. “It’s one of the strongest selective signals we have in the human gene pool,” says Krause.

Early investigations of Ötzi’s body in the 1990s found evidence of melanin pigment in his skin, says Krause, suggesting that he had dark skin pigmentation. Nevertheless, most reconstructions portrayed him as having light pigmentation.

“It used to be that you would depict ancient Europeans similar to modern Europeans, but that doesn’t actually have to be the case at all,” says Mittnik. ■

Environment

Wildfires worsened by early plant growth

LEAVES sprouting earlier in the year, linked to climate change, has been intensifying wildfires.

Constantin Zohner at ETH Zurich in Switzerland and his colleagues assessed northern hemisphere plant growth using satellite data from 2001 to 2018 that measured light reflected by plants or emitted during photosynthesis. They also looked at wildfire records for that period. The sooner vegetation grew in a region, the greater the number of wildfires and the larger the area burned. Earlier vegetation growth also correlated with earlier fires (Research Square, doi.org/kprx).

This may happen because the plants suck water from the ground earlier and drop dead leaves earlier, making the conditions ripe for fire, say the researchers. **Chen Ly**



SHUTTERSTOCK/KLUCIAR IVAN

Technology

Lampshade can cut indoor air pollution

LAMP SHADES coated with an iron or copper-based substance could help tackle indoor air pollution.

The air inside buildings can be harmful to health because of toxic volatile organic compounds (VOCs) released by things like cleaning products or during cooking. To tackle this issue, Hyoungil Kim at Yonsei University in South Korea and his colleagues have covered a lampshade with a coating containing copper or iron. It speeds up chemical reactions in the air, using heat emitted from light bulbs to oxidise VOCs until they become carbon dioxide and water. When tested on VOC concentrations in the air of 1 and 10 parts per million, the lampshade coatings removed all the toxins within several hours, the researchers told a meeting of the American Chemical Society in San Francisco on 15 August. **CL**

Animal behaviour

Blackbirds go to sleep earlier when they feel ill

IF BLACKBIRDS feel sick, they go to bed earlier, much like people do.

We can usually weather minor ailments with a few days of rest, but we don't know how wild animals deal with them, says Arne Hegemann at Lund University in Sweden.

Some smaller animals need to find food every day because they don't have big fat reserves, he says. Such species may also be eaten if they are weak. To study how these animals cope with illness, Hegemann and his colleagues caught 45 Eurasian blackbirds (*Turdus merula*) and tagged them with accelerometers to track their movement. About half were injected with a lipopolysaccharide, a compound that mimics a bacterial

infection by provoking the immune system. After being released, the birds were monitored for 48 days. The researchers were able to recover data from 10 of the injected birds and 12 of the non-injected birds.

The immune-challenged birds moved 19 per cent less in the 20 days after their injections than birds that didn't get an injection. This was largely due to the "sick" birds resting about an hour earlier in the evening than the control group. During the core hours when the birds are most active, however, the activity levels of both groups were roughly equal (*Proceedings of the Royal Society B*, doi.org/kpww).

"It was always assumed that sick birds go back to normal after 24 or maybe 48 hours," says Hegemann. "The really unexpected thing is that there's a change in behaviour for up to three weeks."

The effects of illness may be more severe at certain times of the year, such as when animals feed their young or in winter, he says. **CL**

Really brief



ESO/L. CALÇADA

A strange new type of magnetic star

We finally know why star HD 45166 (illustrated above) looks so unusual. It has an extraordinarily powerful magnetic field, which is probably trapping material in arcs between the star's poles. It may one day collapse and become a magnetar, a highly magnetic neutron star (*Science*, doi.org/kpw7).

Morning-after pill's effect boosted

Emergency contraceptive levonorgestrel is more effective at preventing pregnancy if taken with anti-inflammatory drug piroxicam. The combination prevented 95 per cent of expected pregnancies compared with 63 per cent in people taking a placebo with the morning-after pill (*The Lancet*, doi.org/kpw8).

Blur your screen to stop snoopers

Making your smartphone's screen blurry so it is readable up close but indecipherable at a distance could stop people seeing your private chats or photos. The method reduces the ability of people looking over a user's shoulder to recognise text and images by 60 per cent (arXiv, doi.org/kpw9).

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The columnist

Graham Lawton on species named after dodgy people **p22**

Aperture

Mysterious sand drawings from 136,000 years ago **p24**

Letters

Going with the lottery herd could cost you dear **p26**

Culture

A teen has to escape from inside a sea beast in *Whalefall* **p28**

Culture columnist

Jacob Aron tries to save the world in *Viewfinder* **p30**

Comment

Hot dogs (and birds)

Global warming isn't only affecting animals like polar bears. African wild dog populations may also collapse, warns **Daniella Rabaiotti**

WHEN you consider the effects of climate change on wildlife, what comes to mind? Perhaps a polar bear or a walrus perched on a melting iceberg. Maybe you envision coral bleached white as sea temperatures rise. What you probably didn't imagine though, is climate change's impact on an African wild dog.

My first encounter with the species was in Laikipia, Kenya, back in 2012. An African wild dog emerged from a nearby bush, sporting a very fetching GPS collar. His exquisite tan, black and white markings immediately caught my eye, and I fell in love with the joyful vocalisations of the pack that emerged around him. Little did I know that just two years later, I would begin nine years of research into these animals, during which time I would use data from that very dog.

African wild dogs might not be the obvious poster species for climate change – they inhabit the tropics, far from melting ice or warming oceans, living across vast stretches of Africa. Yet as I, with colleagues at the Zoological Society of London and elsewhere, began to look for temperature impacts on the species, there was no shortage of evidence.

Initially, my colleagues discovered that when it is hot during the crucial three months when African wild dogs raise their pups in dens, fewer pups survive until adulthood. My colleagues and I then found that, at our site



SIMONE ROTELLA

in Laikipia, hotter denning periods resulted in longer intervals between litters, and that adult survival was lower after periods of hot weather.

We found a relationship between wild dog behaviour and temperature, with hot weather leading to less daytime activity, when these carnivores do most of their hunting. We think they get less food in hot weather, leading to impacts on reproduction and potentially survival.

Finally, just last year, colleagues in Botswana found that high temperatures in one denning period were correlated with wild

dogs breeding later the next year, causing the denning period to fall at a hotter time of year.

All this research highlights how high temperatures harm the species. When I brought these results together, modelling the impact of future climate change scenarios on our study population in Kenya, large negative population impacts were predicted. With warming in line with a 3°C temperature increase by 2070, our study population was predicted to collapse within the next 75 years.

Sweeping impacts on species adapted to hot weather aren't

unique to African wild dogs. One research group in South Africa has found multiple impacts of high temperatures on the southern pied babbler in Africa's Kalahari desert. In hot weather, these birds hunt less successfully, feeding their chicks less, leading to fewer reaching adulthood – a similar story to the one we have pieced together for the African wild dog.

Thorough assessments of climate risks like these were only possible because of detailed, long-term studies, which are increasingly difficult in today's short-term funding environment. As a result, in-depth work into the links between behavioural change at high temperatures and climate change impacts on survival and reproduction only exists for a handful of species.

We don't know how many species will be similarly affected – changing their behaviour in hot weather in a way that negatively affects survival or reproduction to the extent it threatens entire populations. It is certainly a lot more than we have quantified the threats for to date. But through close and careful observation of species, we can identify climate risks, integrate climate change into our conservation planning and work to reduce its impacts before it is too late. ■



Daniella Rabaiotti is at the Zoological Society of London's Institute of Zoology

No planet B

What's in a name? Is it time to do away with species names that honour disreputable people past and present, or will that do more harm than good to biodiversity research, asks **Graham Lawton**



Graham Lawton is a staff writer at New Scientist and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

Graham's week

What I'm reading

Testicular cancer memoir
Can I Have My Ball Back?
by Richard Herring.

What I'm watching

Painkiller on Netflix,
a dramatisation of the
US opioid epidemic.

What I'm working on

Getting over the finish
line before my holidays.

This column appears
monthly. Up next week:
Annalee Newitz

A FEW years ago, I visited Slovenia to do a story on the olm, a type of salamander that lives exclusively in caves in the western Balkans. As a result (and as is my wont) I got a bit obsessed with troglobites, creatures that spend their entire lives in underground caves. That led to my first encounter with a notorious beetle called *Anophthalmus hitleri*, discovered in the same cave system in 1933 by a Nazi entomologist who named it after... you know who.

The beetle is now endangered, having become a prized item among collectors of Nazi memorabilia. It looks destined to follow the extinct insect *Roechlingia hitleri* into the dustbin of biodiversity.

A. hitleri has since become embroiled in a wider debate about organisms named after disreputable characters past and present. In 2022, botanists Gideon Smith and Estrela Figueiredo published an article in *Taxon* arguing that 126 plant names commemorating colonialist Cecil Rhodes are “perceived by many as offensive and unacceptable”. Taking their cue from the Rhodes Must Fall movement, which started in South Africa and spread to the US and UK, they proposed that species names were like statues and should be toppled.

This isn't just about cleansing the tree of life, but also undoing colonialism's continued stifling effect on African botany. Many former colonies didn't have research collections until the 20th century, and most remain understaffed and reliant on foreign expertise.

The call was taken up by other taxonomists. Similar proposals have been made for North American freshwater fish and extinct hominins. Earlier this year,

a team of biologists argued in the journal *Nature Ecology & Evolution* that all colonial-era names across the tree of life should be abolished, along with the entire practice of naming species after individuals.

These “eponyms”, they say, often honour the legacy of people who are undeserving, perpetuate the idea that science is a Western preserve and risk progress in conservation biology. Taxonomy is the backbone of biodiversity research, which many Indigenous people already regard as “white saviours” bossing them around and depriving them of their ways of life. Constant reminders of the

“This isn't just about cleansing the tree of life, but also undoing colonialism's effect on African botany”

colonial past aren't helpful in that respect, say the researchers.

In the colonial era, African and Asian biodiversity was plundered and specimens were shipped to European institutions. Many species were named in honour of colonial masters, Western academics and nobility, who were overwhelmingly white, male, upper class, racist and sometimes slave owners. Indigenous people who had known of these species for generations and had their own names for them were sidelined. Around 20 per cent of all African vertebrate names are eponyms, generally from colonial powers.

The practice continues. In 2018, a Panamanian amphibian was provisionally named *Dermophis donaldtrumpi* to draw attention to the then US president's disdain for environmental policies. In 2017, a Californian moth had been named *Neopalpa donaldtrumpi*

for similar reasons. The names will live long in the record. The ironic motivation for them may not.

The proposals to purge eponyms from taxonomy haven't won universal acclaim. In a response to the *Taxon* paper, Sergei Mosyakin at the M. G. Kholodny Institute of Botany in Kyiv, Ukraine, argued that “science cannot and should not... employ politically motivated censorship and totalitarian cleansing of scientific history”. Others pointed out that wholesale renaming would be time-consuming, expensive and disruptive.

These arguments are valid, but not insurmountable. A mass renaming won't erase the originals from history: conservation biologists are already familiar with names since superseded for other reasons (who can forget *Brontosaurus*?).

The International Commission on Zoological Nomenclature (ICZN) already says that names shouldn't be objectionable, comical or potentially offensive. These rules could be amended to apply retrospectively, though the ICZN isn't keen. Naming rights for new species are already routinely auctioned off to the highest bidder, so why not hold a mass auction for obsolete eponyms?

The authors of the *Nature Ecology & Evolution* piece give another reason for renaming. The task could be given to taxonomists in the countries of origin – a boon to biodiversity conservation in the places that need it most.

I would like to proffer a further reason. It may be too late for *A. hitleri*, but the species named after Trump still need protection. Future collectors of Trumpian memorabilia may push both towards extinction. Some eponyms do more harm than good. Time for a purge. ■

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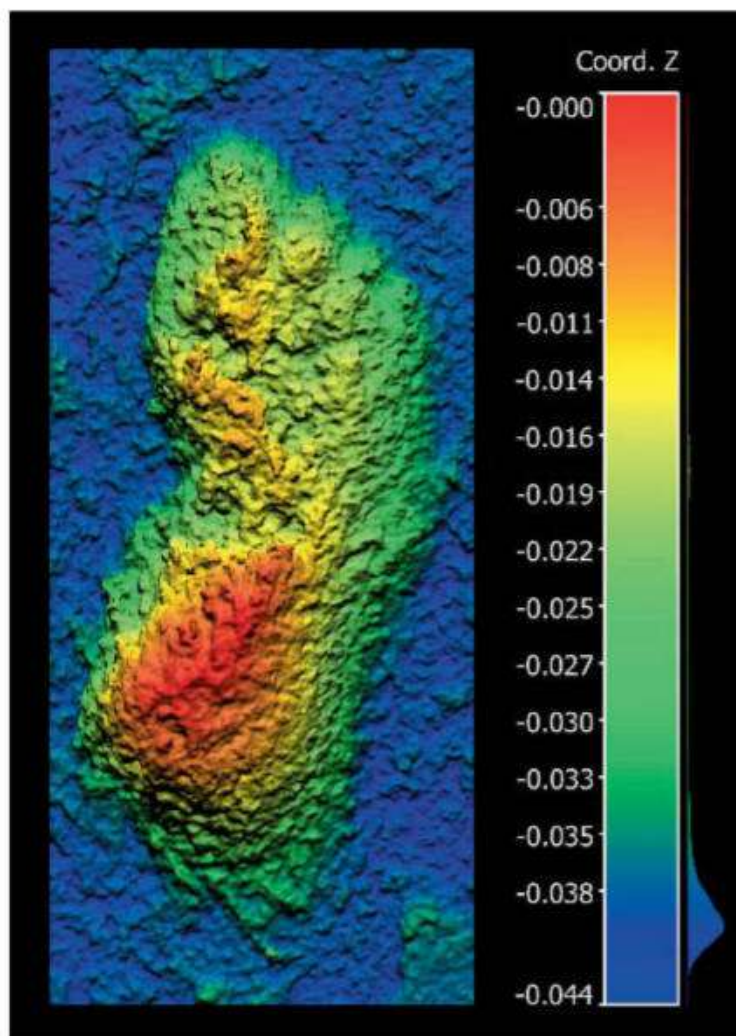
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Sands of time



Charles W. Helm

TAKE a forked stick and plant one of the prongs in sand. Turn it like a compass and you will etch a perfect circle, as demonstrated (far left) on a South African beach by Charles Helm of the African Centre for Coastal Palaeoscience in Gqeberha.

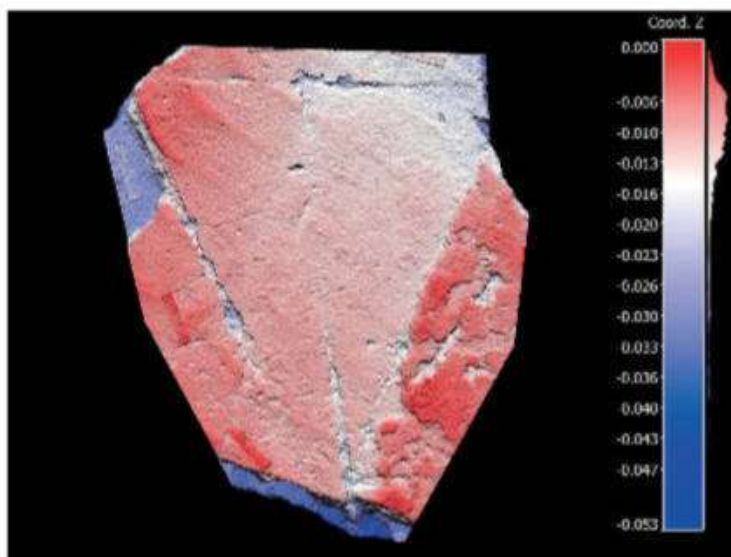
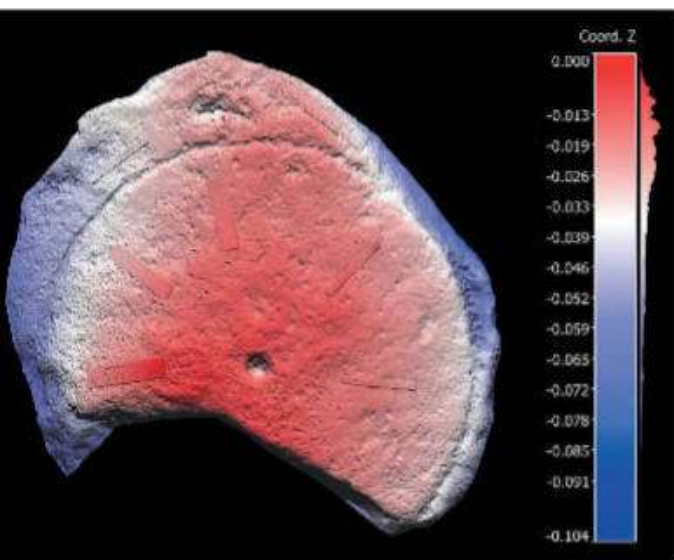
It is a natural human impulse to draw in the sand, and it seems our ancestors were feeling the same drive at least 136,000 years ago. In 2018, Helm discovered a perfect circle with a central depression on a slab of sandstone (middle row) in the Garden Route National Park. This area is known for traces of early *Homo sapiens*, including rock art and the oldest footprint found (top row), which dates back about 150,000 years.

The slab was once the surface of a coastal sand flat that has since solidified into rock. Helm has discovered other patterns in the same outcrop that could have been made by people, including grooves, cross-hatches, parallel lines and a perfect triangle (bottom row). The coloured images represent the depth of the impressions.

Helm ruled out natural causes such as wind, water, non-human animals or vegetation, and was left with one possibility – they were made intentionally by people, though they probably didn't mean much. "I like to think it's kids playing around," says Helm.

He says these sand drawings should be classed as a fifth type of palaeoart, after cave paintings (pictographs), rock engravings (petroglyphs), images carved on trees (dendroglyphs) and arrangements of rocks or earth (geoglyphs). The name he proposes is ammoglyphs, after ammos, the Greek word for sand. ■

Graham Lawton



Editor's pick

Going with the lottery herd could cost you dear

5 August, p 14

From Andrew Mounter,
Alston, Cumbria, UK

The idea of UK National Lottery ticket numbers that mathematically guarantee a win of some kind every time you play perked my interest. But on second thoughts, the numbers given in the article would be the very ones I would avoid as, in the extremely unlikely event of any of the tickets matching the jackpot, I, for one, wouldn't be very happy sharing it with potentially tens of thousands of other hopefuls lured into using those same numbers.

Let's tap into warming seas as a power source

19 August, p 8

From Glenda Dixon,
Hitchin, Hertfordshire, UK

Amid record-breaking warmth in parts of the world, including a rise in sea temperatures, I revisited a discussion with my husband from a few years ago – we are both retired scientists. Why not use thermodynamic systems to get heat from the seas to generate electricity and heat local homes? This could provide significant cooling to water in areas where sea temperature affects the growth of seagrass and coral.

A little less emphasis on bodyweight is needed

12 August, p 21

From Yasmin Porter,
Peacehaven, East Sussex, UK

“A shot of reality” painted a necessary picture of the problem of short-term weight-loss solutions. However, the link between being overweight and serious negative health outcomes remains questionable. Relatively recent evidence suggests there is no difference in mortality risk until either end of the BMI scale, with people in the “overweight”

category having the healthiest biomarkers. Weight isn't the core issue. Instead, we should be focusing on exercise, diet and socioeconomic conditions, as these are the real influences on health.

On the problem of rain overwhelming sewers

12 August, p 36

From Penny Wilde,

Hull, East Riding of Yorkshire, UK

Your report on the problem of raw sewage discharges into rivers during heavy rain indicates one solution is to “green” paved areas in towns to cut runoff. Across the road from me, yet another garden is being paved for car parking. There are few front gardens left on many roads, which is a huge loss of green space across the UK. Hardly anyone I know sees this as a problem or that any climate crisis solutions are their responsibility beyond a bit of recycling.

From Alan Smith, London, UK

When built in the 1930s, no houses in my neighbourhood had rainwater pipes connected directly into the main sewer. Instead, their gutter downpipes fed into rubble-packed underground soakaways. While this doesn't reduce rainwater running into the public sewer network from the street, it must considerably minimise the total volume hitting it.

Bias in science is dwarfed by that in wider society

5 August, p 21

From Geoff Harding,
Sydney, Australia

Dan Levitt writes about the issue of cognitive bias in science. Certainly, most researchers have a problem with this that can adversely affect their work.

Most would admit, perhaps with embarrassment and annoyance, that they missed something in the belief that “it couldn't work”.

However, the problem is endemic elsewhere too, including in people of significant influence in the media, religious institutions and government. The huge problem of climate change is perhaps the supreme example. People often resist change to a comfortable lifestyle. However, bias and mindset can be dealt with via education when young.

From Guy Cox, Sydney, Australia

I have to disagree with Levitt on one point. In my field, cell biology, he claims that the interior of the cell, the cytoplasm, was believed to be just a “biochemical bog” a century ago. But chloroplasts, organelles that carry out photosynthesis in plant cells, were discovered far earlier than that. Mitochondria, the so-called powerhouses of the cell, were recognised in 1857 and the Golgi apparatus in 1897. In other words, by the end of the 19th century – well before 1923 – we knew that the cell had specific compartments for specific functions inside it – far from a biochemical bog.

That quantum computer wormhole is far from real

12 August, p 40

From Gerard Buzolic, Coolumb Beach, Queensland, Australia

Philip Ball writes of physicists puzzled over when a simulation of a physical entity, such as a wormhole, in a quantum computer is actually real.

In my mind, I imagine an animal that is half horse and half lion. No real-world equivalent exists; I have made it in my mind. That is as close as such a creature

comes to being real. Wormholes, as they currently exist in quantum computers, are as real as my “leohippus”. Quantum computers would seem to have good imaginations for wormholes.

Maybe it is time to give up the dream of fusion power

12 August, p 13

From Eric Kvaalen,

Les Essarts-le-Roi, France

You report the latest instance of hope in the efforts to develop nuclear fusion as a viable power source for our societies, in this case involving a set-up in which more energy emerged from a fusion reactor in the US than was put into it, so-called ignition.

You say that such advances mean “the science is sound, and the problem is now one of engineering rather than physics”. But inertial confinement, the design used in this case, probably won't work out commercially – the hope is for doughnut-shaped tokamak reactors instead.

Research has also shown that fusion will be more costly than renewable energy even if we crack it. Maybe it is time to give up on it.

The problem is that we find hypocrisy easy

29 July, p 29

From Ben Haller,

Ithaca, New York, US

Your review of author Marjolijn van Heemstra's book includes the quote: “Begin your day with what you truly are – deeply improbable. If we appreciated this fully, wouldn't we take better care of each other and the planet?” I appreciate the optimism, but remain sceptical.

Many people believe that they, and this planet, were created by an all-loving deity they worship – and yet show little interest in caring for each other or the planet. The conclusion is that we are very good at rationalising selfishness, regardless of the beliefs we claim to hold. This must change. ■



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Escape from a whale

A troubled young man is swallowed by a whale as he hunts for his father's remains in a novel like nothing you have read before, says **Neil McRobert**



Book

Whalefall

Daniel Kraus

Simon & Schuster

US: hardback

UK: Ebook; hardback 9 November

COMPARISONS are a reviewer's best friend. Not sure how to fully describe the impact of a novel? Simply find other titles that contain elements of the story in question and use them to help do the work.

Daniel Kraus's *Whalefall* comes especially freighted with ready-made associations. *Moby-Dick* by Herman Melville is the obvious reference point. After all, Kraus's novel also focuses on an intimate relationship between man and whale. Intimacy in extremis, in this case, as the bulk of the story is told from within a sperm whale's stomach, where our 17-year-old protagonist, Jay, has only an hour's worth of air left in his oxygen tank. Yes, *Whalefall* is about a man who is swallowed by a whale.

But an opening epigram aside, neither Melville's classic nor the Biblical Jonah have any real traction in *Whalefall*. Closer comparisons could be made to Ernest Hemingway's novella, *The Old Man and the Sea*, in which the fish on the end of the line represents both real, physical struggle and allegorical crisis.

Then there is Andy Weir's *The Martian*. That novel's ingenuity-on-the-fly adventures are mirrored in Jay's desperate attempts to construct an escape plan out of the detritus inside his fleshy cell. Who knew a jellyfish could prove so useful?

In truth, any direct comparison does a disservice to the individuality of Kraus's novel. It is a sensory epic, both inside and



BLUE PLANET ARCHIVE/ALAMY

outside the whale. An early section introduces us to Jay (and, importantly, to his rudimentary scuba kit) while he swims out to sea in search of the remains of his father, a local diving legend. An encounter with some gigantic undersea fauna features all the awe and appalling human diminishment common to tales of cosmic horror. Thalassophobes, those who fear deep bodies of

“Jay’s attempts to construct an escape plan mirror *The Martian’s* ingenuity-on-the-fly adventures”

water, will find the descriptions of things gliding from hidden depths completely unnerving.

However, once Jay finds himself inadvertently swallowed, Kraus changes aesthetic tack. There is no room for grandeur inside a stomach and Jay's bodily experience becomes a gauntlet of broken bones, acid burns and blubbery pulverisation.

His mind, however, is a different

seascape. Jay's fractured relationship with Mitt, his troubled, charismatic father, forms *Whalefall's* emotional spine. Jay felt misunderstood by his father, and Mitt's unforgiving lectures about exploring the ocean drove a wedge between them, left unreconciled by his death.

In the gastric dark, Mitt's disembodied voice and Jay's reconsidered memories begin to unpick this narrative. One flashback, in which Mitt teaches his son to control his anxious breathing, proves both life-saving and heartbreakingly poignant. Jay laments that he had lessons rather than love. As the book reveals, the lessons were the love.

Whalefall's best trick is the ambiguity of Mitt's presence. Is he a product of Jay's hypoxia? A memory? A ghost? Or does he – as the novel seems to want us to believe – exist in some strange liminal state, as the whale?

If it is the last of these, Kraus offers a satisfying, if slightly heavy-handed, metaphor for a boy's need to escape his father. It also makes sense of the emotional

In a strange shift, Jay comes to care for the sperm whale's well-being

pivot in which both Jay and, I suspect, most readers come to care for the well-being of what is in effect his sentient prison. An orca pod attack is devastating, even if Jay's perspective reduces it to sound and vibration. It is a blind view of brutal magnificence.

The poetry of the prose aside, *Whalefall's* anatomical rigour supports the story. Kraus's speculation may be based in theoretical possibility rather than fact, but he exploits both our knowledge of and uncertainty about whale interiors to great effect. Armed with this breadth of research, and a standard of prose that evokes Cormac McCarthy at his most symbolic, Kraus turns the literal guts of this novel into a haunted house, a torture chamber, a church and a uterus for belated rebirth. There is nothing else quite like *Whalefall*. ■

Neil McRobert is a writer and podcaster based near Manchester, UK



Clare Wilson
Reporter
London

TV-wise, I have been decompressing with the light-hearted crime series **Poker Face**. In it, chief protagonist Charlie (pictured), played by Natasha Lyonne, is a down-on-her-luck



casino worker with an infallible ability to tell when someone is lying.

On the run from a grudge-bearing casino boss, Charlie pinballs around the US, solving crimes at every turn. It's a fun twist on the usual whodunnit format – becoming more of a how-to-prove-they-dunnit, but I couldn't help being distracted by imagining how I would personally have put Charlie's superpower to more profitable use.

At the cinema, I succumbed to peer pressure and saw **Oppenheimer** and **Barbie** in quick succession. I thought they complemented each other beautifully, and it was great to see so many people dressing up in pink in homage to the iconic toy. As a long-time fan of fancy dress, I hope wearing film-themed clothing for cinema trips becomes de rigueur.

Mendel's new place

Where does “father of genetics” Gregor Mendel fit in a post-genomic world? **Simon Ings** explores an excellent reset



Book
Disputed Inheritance
Gregory Radick
University of Chicago Press

IN 1865, an Austrian monk called Gregor Mendel, working to understand hybridisation, uncovered exquisitely simple and reliable patterns of inheritance in varieties of garden pea. In 1900, the patterns he described were rediscovered and thought by some to reveal the existence of hereditary “particles” – particles that we now call genes. With this, Mendel became “the father” of genetics.

Well, of course there is more to the story, as we discover in *Disputed Inheritance: The battle over Mendel and the future of biology*, an ambitious work by science historian Gregory Radick. In paying attention to today's sophisticated ideas about genetics, Radick poses a deceptively simple question: why, he asks, knowing what we do now, do we still bother with Mendel? Why, when we explain genetics, do we reach

for experiments conducted by a man with no interest in heritability, never mind evolution? And one, he argues, whose conclusions on heritability (in as much as he ever made any) were spectacularly contradicted in experiments with pea hybrids by Thomas Laxton, Charles Darwin's favourite botanist, in 1866.

The evidence against Mendelian genetics began accumulating almost immediately after its rediscovery. Modern genetics is arguably not Mendelian, it is molecular, informed by the likes of microbiology, biochemistry, X-ray crystallography and, later, a host of data-rich sequencing technologies.

Radick underlines this shift by citing a 2014 paper by evolution theorist Evelyn Fox Keller. She writes that the genome is reactive, “a device for regulating the production of specific proteins in response to the constantly changing signals it receives from its environment”, rather than the pre-genomic picture of a static collection of genes leading inexorably to inherited traits.

The point isn't that Mendel was wrong. That would be like saying Isaac Newton was wrong for not coming up with general relativity. The point is we may have no real

need to think in Mendelian terms at all. Couching almost all of modern genetics as an exception to Mendel's specious “rules” is to constantly explain everything backwards.

Radick outlines how we got here, and what we can do. The seed of trouble was sown in the battle between two zoologists, William Bateson at the University of Cambridge, who made it his mission to reshape biology in the image of Mendel's experiments, and Raphael Weldon at the University of Oxford, who saw that Mendel had removed from his experiments as many sources of variability as he could.

Real peas aren't always just yellow or green, or just round or wrinkled, and Weldon argued that variability shouldn't be idealised away. “It seems to me that every character is at once inherited and acquired,” wrote Weldon. He was right: the difficulty was what to do with that insight. “It is easy to say Mendelism does not happen,” he remarked to his friend Karl Pearson in 1903, “but what the deuce does happen is harder every day!”

Weldon needed (and pursued) an alternative theory of heredity, but his manuscript setting it out was unfinished by his death in 1906.

Radick champions the underdog Weldon over the victorious Bateson. Whether his account smacks of special pleading depends on the reader's education and interests. Temperatures in this field run high: less than a century ago, geneticists in the Soviet Union were ruined – some even died – defending Mendel's idea, insufficient as that idea can seem to us now.

This isn't the first attempt to lay history's ghosts to rest and reset our ideas about genetics. That said, I can't think of one that is better argued, more fair-minded or more enjoyable. ■

Simon Ings is a writer based in London

A painting showing Gregor Mendel at work in his garden, where he studied garden peas



The games column

Finding your level *Viewfinder* is set in a world ravaged by climate change, where the researchers trying to help have fled. Can you retrieve their work and save the world? Success depends on cunning tricks with dimensions, says **Jacob Aron**



Jacob Aron is *New Scientist's* news editor. Follow him on Twitter @jjaron



A scene from *Viewfinder*, a well-paced first-person puzzle game



Game
Viewfinder
Sad Owl Studios
PC, PlayStation 5

Jacob also recommends...

Games
Portal
Valve
PC, PlayStation 3, Xbox 360, Nintendo Switch
Now more than 15 years old, this absolute classic puzzle game still has the power to impress.

Antichamber
Demruth
PC

With no real story to speak of, this first-person puzzler puts the focus on navigating bewildering and impossible non-Euclidean geometries.

WITH near-ubiquitous access to cameras and screens, it can be hard to remember that the idea of representing 3D objects on a 2D image was once at art's cutting-edge. Exactly when this happened is debated, but we can reasonably say the practice of drawing scenes with realistic perspective took off in the 15th century.

Personally, I have been given a new perspective on perspective by playing *Viewfinder*, a first-person puzzle game that is all about the interplay between two and three dimensions. The story is light, but compelling: in a world ravaged by climate change, you enter a simulated environment that was abandoned by researchers seeking a solution. By going deeper into the simulation (playing through levels), you hope to recover their work and save the world.

What this comes down to is a series of puzzles and evolving mechanics very much modelled after *Portal*, arguably the original first-person puzzler, while maintaining a fresh and unique identity. Each level involves reaching, and in some cases

powering up, a teleporter that takes you to the next level.

Your ability to manipulate the world is fairly limited at first. By picking up photos you find, you can place them in the environment and the contents of the image spring to life, fully formed in 3D – a clever trick that never loses its appeal. In early levels, this might

“The end of the game was far more nuanced and thoughtful than I was expecting, a rarity in the gaming world”

mean using a photo of a battery to create a real battery to power the teleporter, or a photo of a bridge to let you reach a distant path.

From there, the complexity increases, but it is never overwhelming. In later levels, photos might be sliced into pieces in multiple locations, forcing you to find the spot that will bring them all together with the right perspective and render them real.

Eventually, you receive a Polaroid camera that lets you take

your own photos, providing more freedom and creativity with which to manipulate the world. At times, I was sure there was no way I was solving a puzzle as the developer, Sad Owl Studios, intended – some of my solutions exploited the game's physics in janky ways, but that is part of the fun.

I don't want to spoil some of the later mechanics: it is enough to say that they are all extremely clever and fun to play with. Being able to use a photocopier was a particular highlight for me, which is a sentence that I am not sure anyone has ever uttered.

As you progress through the levels, you learn more about the scientists behind the simulation and meet CAIT, a Cheshire Cat-like artificial intelligence that pops up and comments on what you are doing. It is all very charming, if a little bit vague at times because much of the story is told through sticky notes and audio recordings that can be easy to miss if you are busy concentrating on the next mind-melting puzzle.

Viewfinder is well-paced, exploring its ideas without outstaying its welcome, and only makes a very slight misstep in the last level, which essentially serves as a final test of the skills you have learned, racing against a timer I found far too stressful. Thankfully, there is an option in the menu to turn the timer off, which is a very welcome decision. The end of the game was also far more nuanced and thoughtful than I was expecting, which is a rarity in the gaming world.

All in all, if you have an interest at all in puzzles and playing with spaces, you should definitely take a look at *Viewfinder*. ■

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Nowhere to hide

The way your data is stored and shared online is changing – and you might be surprised to find how even mundane online activity can have a drastic influence on your life, finds **Amanda Ruggeri**

ONE Friday in 2021, I walked into a hotel in Exeter, UK, at 17:57:35. The next morning, I drove 9 minutes to the nearby hospital. I stayed for three days. The drive home, normally 1 hour 15 minutes, took 1 hour 40 minutes. The reason for the slow speed, my brand-new baby, dozed in the back.

These aren't details from a journal. Instead, they are what Google knows about my daughter's birth, based on my location history alone.

A data snapshot of that weekend reveals this isn't all that companies know about me. Netflix remembers that I watched a variety of feel-good fluff including *Gilmore Girls* and *How to Lose a Guy in 10 Days*. Instagram recorded that I "liked" a post about labour induction, then didn't log in again for a week.

So what? We all know by now that we are being tracked online, and that the data collected on us is both granular and constant. Perhaps you like that Netflix and Instagram know your film and fashion tastes so well.

But a growing number of investigations and lawsuits reveal a new online tracking landscape in which the reach of companies that harvest data is more insidious than many of us realise. When I looked more closely, I found that my personal data could be affecting everything from my job prospects and loan applications to my access to healthcare. It may, in other words, be shaping my everyday life in ways that I was unaware of. "The problem's huge, and there are always new horrors," says Reuben Binns at the University of Oxford.

You could be forgiven for thinking that, with the introduction of legislation like the General Data Protection Regulation (GDPR) – European Union rules implemented in 2018 that give people more access to the data companies hold on them and limit what firms can do with it – data privacy is no longer a real issue. You can always opt out of cookies if you don't want to be tracked, right? But when I say this to Pam Dixon at non-profit research group World Privacy Forum she starts laughing in disbelief. "Do you really believe that?" she says.

Data scrapers

Hundreds of fines have been issued for breaches of GDPR, including against Google, British Airways and Amazon. But data experts say those are just the tip of the iceberg. A study last year by David Basin at ETH Zurich in Switzerland found that 95 per cent of websites may be breaking GDPR rules. Even the legislation's aim to make it easier to understand what data we are agreeing to provide has gone unrealised. Since the legislation came into effect, research shows that privacy agreements have become more convoluted, not less. And if you thought that ad-blockers and virtual private networks (VPNs) – which hide your computer's IP address – offer protection, think again. Many of these services also sell on your data. We are only now grasping the scale and intricacy of the online tracking landscape. A few big names – the likes of Google, Meta,

Amazon and Microsoft – hold much of the power, says Isabel Wagner, associate professor of cybersecurity at the University of Basel, Switzerland. But behind these big players, a diverse ecosystem of thousands, if not millions, of buyers, sellers, servers, trackers and analysers are sharing our personal data.

What does all of this mean for a regular user like myself? To find out, I have come to HestiaLabs in Lausanne, Switzerland, a start-up founded by Paul-Olivier Dehaye, a mathematician and key whistle-blower in the scandal surrounding the use of Facebook data by the political consulting firm Cambridge Analytica. The company used personal data to influence Donald Trump's election as US president in 2016. Dehaye's investigation into Cambridge Analytica starkly demonstrated how deep the influence of companies that buy and sell data goes. He set up HestiaLabs to change that.

Before arriving, I have requested my personal data from a variety of companies, itself a more complicated process than it should be in the post-GDPR era. I meet Charles Foucault-Dumas, HestiaLabs's project manager, at the firm's HQ – a modest co-working space across from Lausanne's train station. We sit down and upload my files into its bespoke portal.

My data spreads before me, visualised as a map of every place I have ever been, every post I have ever liked and every app that has ever contacted an advertiser. At places I frequent regularly, like my daughter's nursery, ➤



MICHAEL KIRKHAM



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hundreds of data points morph into paint-like blobs. At my home address, there is a huge, impossible-to-miss bullseye. It's compelling. And a little terrifying.

One of the biggest surprises is which of my phone's apps are contacting third-party firms on my behalf. The biggest offender in the past week, contacting 29 companies, was a web browser I use because it describes itself as "privacy first". But pretty much every app on my phone, from a grocery service to a virtual notepad, was busy contacting other firms while I went about my day.

Generally speaking, a company that wants to sell a product or service talks to an ad agency, which connects with platforms that deal with advertisement delivery, which use ad exchanges, which link to supply-side platforms, which place ads on publisher websites. Every time you open a website or momentarily hover on a social media post, this machine – estimated to be worth £150 billion a year – kicks into motion.

What exactly were these companies sharing about me? To find out, I would have to put in requests with each separate company. And even with the ones that I have contacted with the help of HestiaLabs, it isn't always clear.

Take Instagram. It has provided me with data showing it has recorded 333 "interests" on my behalf. Some of them are way off the mark: rugby, the Burning Man festival, real-estate development, even "cat lady". Reader, I have never owned a cat. But others are more accurate, and a number, unsurprisingly, have to do with my becoming a parent, ranging from brands like Huggies and Peppa Pig to topics like bassinets and baby-led weaning.

I find myself wondering how this data may not only have affected my purchases, but also my daughter's life. Is her love of the pink cartoon pig really organic, or were we "served" these videos because of information Instagram passed on about me? Did baby-led weaning posts wind up all over my feed – and therefore influence how my daughter was first introduced to food – by chance, or because I had been targeted? I have access to none of this cause-and-effect chain, nor do I know how these various "interests" might have categorised me for would-be marketers.

It is near impossible to unpick the complex web of backstreet data deals. Personal data is often replicated, split and then fed into algorithms and machine-learning systems.



REUTERS/YUYA SHINO

Your phone tracks your location even if mobile data is switched off

As a result, says Dixon, even with legislation like GDPR, we don't have access to all of our personal data. "There are two strata that we're dealing with. There's the stuff that can be found," she says. "But there is another strata that you cannot see, that you do not have the legal right to see – none of us do."

Boxed up

Recent reports offer glimpses. In June, an investigation in *The Markup* found that this kind of hidden data is used by advertisers to categorise us according to our political beliefs, health conditions and psychological profiles. Might I be deemed a "mobile addict mom", an "indulger", "easily deflated" or "woke"? I have no idea, but I do know these are all actual categories used by online ad platforms.

It is unsettling to think that I am being stereotyped in unknown ways. Another part of me wonders if it really matters. I can see the value in advertising that takes my preferences into account, or in opening my maps app and, say, having restaurants and museums highlighted that I might be interested in or have been to before. But take it from me, there are few ways to make a data expert grimace faster than with the glibness of that trade-off.

For one, the uses of this data go far beyond selling you advertising, says Dixon. Something as seemingly innocuous as whether you shop at discount stores (signalling lower income) or buy sports goods (a tip-off that you exercise) can affect everything from how appealing you look as a university applicant to how much you pay for health insurance. "This is not just advertising," says Dixon. "This is real life."

Recent legislation in the US has forced some of these companies into the light. Vermont's 2018 Data Broker Act, for instance, revealed that data brokers registered in the state – but which are also active elsewhere – sell personal information to potential landlords and employers, often via third parties. And in July, the US Consumer Financial Protection Bureau heard evidence that this hidden second strata of data also includes information used to run a "consumer score", employed much like a credit score. "Things that you've done, websites you've visited, apps that you use, can all feed into services that check if you're a suitable tenant or decide what terms to offer you for a loan or a mortgage," says Binns.

At HestiaLabs, it dawns on me that I, too, may have been concretely affected, not just in terms of ads I see, but because of how algorithms digested my data. In LinkedIn's "inferences", I am identified both as "not a people leader" and "not a senior leader". That is despite my having led a team of 20 people at the BBC and serving as an editor of various BBC sites before that – information I specifically put into LinkedIn myself. How might this be affecting my career opportunities? When I put this to LinkedIn, a spokesperson said that these inferences aren't used "in any way to inform job search suggestions".

Despite this, we know from lawsuits that data was used to exclude women from seeing tech job ads on Facebook. As a result, the platform's owner, Meta, stopped giving advertisers this option in 2019. But data experts say there are plenty of workarounds, such as only targeting people with interests that are stereotypically male. "These harms are not visible to individual users in that moment. They are often very abstract and might happen a long way down the line," says Wagner.

As the data collected about our everyday lives proliferates, the list of harms reported by newspapers keeps growing. Ovulation tracking apps – as well as text messages, emails and web searches – have been used to prosecute women

who had an abortion in the US since the Roe v Wade ruling was overturned last year. Priests have been outed for using the gay dating app Grindr. A Russian military officer was even tracked and killed on his morning run, allegedly due to publicly available data from fitness app Strava. Data protection purports to prevent many of these harms. “But there is obviously a huge gap in enforcement,” says Binns.

Part of the issue is a lack of transparency. Many companies are moving towards “privacy-preserving” models, which break up an individual user’s data points and scatter them across many computer servers, or encrypt them locally. Ironically, this makes it harder for you to access your own data and try to figure out how it has been used.

For his part, though, HestiaLabs’s Dehaye is clear that these companies can and should give us back control. “If you go and consult a website right now, within hundreds of milliseconds, lots of actors will figure out who you are and whose website you’ve put shoes into a shopping basket on two weeks ago. When the goal is to show you a crappy ad, they’re able to resolve all of those problems,” he says. “But when you make a privacy request,

“The apps you use can feed into services that decide on your mortgage terms”

they’re like, ‘Oh, shit, how do we do that?’”

He adds: “But there is a way to use this force of capitalism that has solved a problem in a billion-dollar industry for you – not for them.”

I hope he is right. As I walk through Lausanne after leaving HestiaLabs, I see a man lingering outside a knife shop, his phone outlined in his pocket. A stylish woman carries a Zara bag in one hand, her phone in the other. A man outside the police station talks excitedly into his device.

To me, and probably to them, these are

brief, forgettable moments in time. But to the companies that harvest data, they are opportunities. They are dollar signs. And they are data points that might never go away.

Based on tips I have picked up from Dehaye and the other experts I have interviewed, when I get home, I audit my apps, deleting those I don’t use. I also delete some of those I use but that are particularly eager to contact companies, planning to use them just on my laptop instead. (I used a platform called TC Slim to tell me which companies my apps are contacting.) I also install a new browser that (it seems) is genuinely privacy first. Open source and non-profit apps and browsers can be safer choices, says Wagner, as they have little incentive to collect your data.

I also start to turn my phone off more often when I am not using it. This is because your phone usually tracks your location even when you have mobile data and Wi-Fi off or airplane mode on. And, logging into my Google preferences, I opt out of saving my location history, even though nostalgia – for now – keeps me from requesting that all of my past data be deleted.

We can also reset our relationship with online tracking by changing how we pay for things, says Dixon. She suggests using a variety of credit cards and being “very careful” about which digital wallet we use. For purchases that could create a “negative” signal, like those made at a discount store, use cash, if possible. Dixon also counsels against using health-related apps or websites, if you can. “It’s just not a clear, safe space,” she says.

The reality is, though, that whatever steps you take, companies will always be engineering new workarounds. “This is a game you can only lose,” says Dehaye. That’s why the solution doesn’t come down to individuals, he says. “This really needs to be a societal shift.”

With enough individual voices put together, Dehaye believes we can change the system – and that this all begins by you requesting your data. “Tell companies: ‘If you slip, then our trust is gone,’” he says. “And in this world of data, if people don’t trust your company, you are dead.” ■

Shopping at discount stores can harm your credit score



TONY GUTIERREZ/ASSOCIATED PRESS/ALAMY



Amanda Ruggeri is an award-winning freelance journalist and editor based in Switzerland

Wringing out the world

We have broken Earth's water cycle. How did it come to this and is there anything we can do to fix it, asks **Graham Lawton**

I TRAVEL a lot for work, and everywhere I go people talk about rain. I was in Uganda last November and heard grumbles that the rainy season had failed to arrive. In Albania in March, I read about plans to export water to drought-stricken Italy. I visited Saudi Arabia in June and was told about an unexpected torrential downpour in the desert.

It is easy to shrug at all this. After all, we already know climate change is disrupting the weather. And the rain will fall eventually because water is infinitely renewable. It falls from the sky as rain, variably but reliably. Doesn't it?

The answer, increasingly, is no. "We've allowed ourselves to think that water is simply something that comes back every year and there's a stable water cycle and we can trust it," says Johan Rockström at the Potsdam Institute for Climate Impact Research in Germany. But that is changing as a result of human activity. "We must recognise that – oh my God – we're actually not able to trust the source any more."

This isn't vague scaremongering. Rockström has just carried out a serious analysis of our water systems and concluded that they are broken. So how bad is the damage? And is there anything we can do as individuals or as a society? Broadly, the answers are that the damage runs deep, but it is still fixable – just.

The hydrological cycle is a complex, interconnected system that circulates freshwater between rivers, lakes, wetlands, groundwater, ice, water vapour in the atmosphere, clouds and precipitation. It has been extremely stable during the Holocene, or the past 11,700 years, during which temperate climatic conditions have allowed humans to thrive. But geologists are on the cusp of

declaring that we are now in a new, human-influenced geological epoch called the Anthropocene. Part of our impact is that we increasingly suck the system dry, extracting ever-more water for agriculture, industry and use in our homes. Until recently the hydrological cycle could cope, but there are signs that the taps are about to turn off.

In March, in recognition of a looming crisis, the United Nations convened a Water Conference in New York, only the second in its history. The first was in 1977, in Mar del Plata in Argentina, where 118 countries agreed that there should be universal supply of water and sanitation by 1990. "We are now in 2023 and we know how far away we are still from that," says Pablo Berceartua, chair of the Global Water Partnership, a network that includes thousands of water-related agencies.

But it is even worse than that. The word on everyone's lips at this year's conference was "crisis". Not only do 2 billion people lack adequate access to clean water, the entire hydrological cycle is being thrown out of its comfort zone by the double whammy of climate change and land degradation. Some places are getting wetter, others drier. The net result is that the largely stable distribution of rainfall in which humans evolved and flourished is no longer. "There is simply not enough fresh water left any more," Hungarian diplomat Csaba Kőrösi, president of the 77th session of the UN General Assembly, told the conference.

In 2009, Rockström, who was then at the Stockholm Environment Institute in Sweden, pioneered, with others, the concept of "planetary boundaries", nine global life-support systems that we must keep within certain limits to maintain a habitable Earth.



One of them was freshwater use, which Rockström and his colleagues decided – unlike climate change, biodiversity loss and the nitrogen cycle – was still well within safe limits. They defined the boundary as consumption of no more than 4000 cubic kilometres of fresh water per year, and said that actual consumption was 2600 cubic kilometres per year. But they warned that, under a business-as-usual scenario, the boundary would be approached by mid-century. They reviewed this position in 2019 and concluded that, again, freshwater use was within safe limits.

Now, however, the situation has taken a dramatic plunge. The original planetary boundaries analysis only considered the extraction of fresh water. In a new paper, Rockström and his colleagues did a more detailed analysis based on new science. They created two new freshwater boundaries: flow alteration of surface water and extraction of groundwater. The former is key to freshwater biodiversity, drinking water and the fisheries upon which millions of people depend; the latter contributes to flows in river systems and sustains wetlands and plants.

System breach

We are breaching both. For flow alteration, they set the boundary as a 20 per cent decrease or increase over the natural flow. “Once we start altering flow regimes by more than 20 per cent, we start to see significant impact to freshwater systems and the essential services that they provide [to humans],” says Stuart Bunn, a co-author of the paper who is at the Australian Rivers Institute at Griffith University, Brisbane. Globally, we are within the boundary, but a third of land areas, which are home to half the world’s population, have exceeded it.

The situation for groundwater is even worse. For this, the researchers defined the boundary as extraction not exceeding replenishment. By that reckoning, 47 per cent of the world’s groundwater basins are in decline. This is enough to push us over the global boundary. It was recently reported that humanity has extracted so much groundwater that the planet has shifted on its axis. The water is still there, but has been redistributed from below to above ground, causing the poles to move by about 80 centimetres.

That conclusion is made even more alarming by a separate study, also conducted by Rockström and his colleagues and published last year. It proposed a new planetary



boundary called green water. This refers to moisture in the soil and atmosphere, which comprises around two-thirds of all fresh water on Earth. Surface water such as that in rivers, lakes and reservoirs is classed as blue water, as is that within aquifers.

Green water is the lifeblood of the water cycle. “It powers all biomass production on Earth, secures food security and is the basis also for large parts of livelihoods and economic development,” says Rockström. Around half of all rainfall comes from the venting of green water vapour into the atmosphere from trees and other plants, a process called transpiration. The vapour will often travel long distances in the atmosphere before eventually falling as rain. Some of the UK’s rainfall, for example, originates in the forests of central Europe.

The criterion Rockström and his colleagues set to assess this precious, but long-neglected resource is the percentage of ice-free land in which soil moisture in the part of the ground

where we find plant roots significantly deviates from its normal baseline for a whole month. Soil moisture is a good indicator of the state of green water as it is directly affected by changes in the two fundamental processes of the water cycle, precipitation and evaporation. They further calculated that if more than 10 per cent of ice-free land gains or loses excessive amounts of soil moisture, the green water boundary is a busted flush.

Clear green water

The estimate of Rockström and his colleagues, based on pre-existing soil moisture data, is that this boundary has been exceeded across 18 per cent of ice-free land, meaning that it has been “considerably transgressed”.

This is due to climate change, but also alterations in land use, says Rockström. “When we have deforestation, we lose the green water flow,” he says. In the Brazilian Amazon,

for example, tree loss has greatly lowered the amount of water vapour entering the atmosphere, reducing rainfall across the region. Deforestation of the Congo river basin is depriving Nigeria and other countries in West Africa of their once-reliable rainy seasons. Similar things are happening across the world, as formerly intact ecosystems are deforested and degraded. Add this all up and we are facing a completely new magnitude of global water crisis, says Rockström. “We are taking colossal risks with the future of civilisation.”

It seems, then, like we need to engage in a wholesale recalibration of the way we use water. I wondered to what extent our personal water use is to blame for the crisis. To find out, I decided to take a look at my own water footprint.

I live alone in London, and according to the bill from my water supplier, I use 110 litres a day on average. This is less than is typical for a single-person household, which is 150 litres a day. But it still seems an awful lot, about half a bathtub. I drink maybe 2 litres a day and use another 30 to 40 in the shower (yes, I measured it). The bulk comes from running my washing machine and dishwasher, flushing the toilet and watering the garden during our increasingly parched summers.

That is just my direct use of water, though. All of us also use vast quantities indirectly, in the sense that more or less everything we use and buy – from food to clothes and the packaging they come in – requires water to produce. According to Rockström, the average person needs 3000 litres a day to support their basic needs when you consider both indirect and direct usage. That is 1200 cubic metres per person per year, about what is needed to fill three 25-metre swimming pools.

I estimated my own combined consumption online using the Extended Water Footprint Calculator created by the Water Footprint Network, a collaboration between companies, organisations and individuals. I discovered that I use roughly 430 m³ per year, or 1180 litres a day. That is fairly low, but I don’t eat meat, I avoid dairy and I don’t have a car to wash.

By far the biggest component of my water footprint comes from the food I buy: 30 m³ per year from vegetables, 61 from fruit and a shocking 153 from coffee. I don’t drink half a swimming pool of coffee a year – half a litre a day at most – but the crop is water-intensive. The UN estimates that a standard 125-millilitre cup of coffee requires 140 litres of water to produce. I had no idea. I just throw a bag



Our water woes are caused by, among other things, deforestation, agriculture and the fashion industry

of coffee beans in my supermarket trolley without a moment's thought. Getting to know your water footprint can be a shock, but it does at least offer the opportunity to change (see "How to cut your water footprint", right). If I switched to tea, that part of my footprint would fall by 53 per cent. But I much prefer coffee.

I guess my reluctance to swap coffee for tea makes me part of what Rockström says is the fundamental problem with our relationship with water. He says that the world has got used to exploiting it as an effectively infinite resource. "It's incredible that somehow the modern world has been allowed to take water for free and for granted."

The action we need to take to rectify this goes way beyond personal choices. We also need systemic changes – and fast. "We broke the hydrological cycle," says Henk Ovink, the Netherlands' special envoy for international water affairs. "Now we have to bring it back again. There's a possibility for that."

The most obvious fixes involve getting to grips with deforestation and keeping global warming to a minimum. But another crucial step, according to a report by the newly-formed Global Commission on the Economics of Water, of which Rockström is a member, is to recognise water as a global common good rather than a national commodity to be profited from and squabbled over. Yet that is easier said than done. "The truth is that we don't have a proper economics of the common good," says commission member Mariana Mazzucato at University College London.

A good start would be to bring green water into the reckoning. "In water policy, we tend to only focus on the blue water," says Rockström. Adding green water would allow neighbouring countries to agree how to co-manage their shared rainfall, much as they often do with blue water.

Plugging the leaks

Farming is a huge consumer of water, accounting for around 75 per cent of global use. That is partly driven by more than \$500 billion a year in subsidies that drive overproduction and overconsumption of water-intensive products in water-scarce regions, says commission member Ngozi Okonjo-Iweala, director-general of the World Trade Organization. Global trade can help, she says, with thirsty crops grown in wet countries and dry-tolerant crops in drier ones, and then exported.

How to cut your water footprint

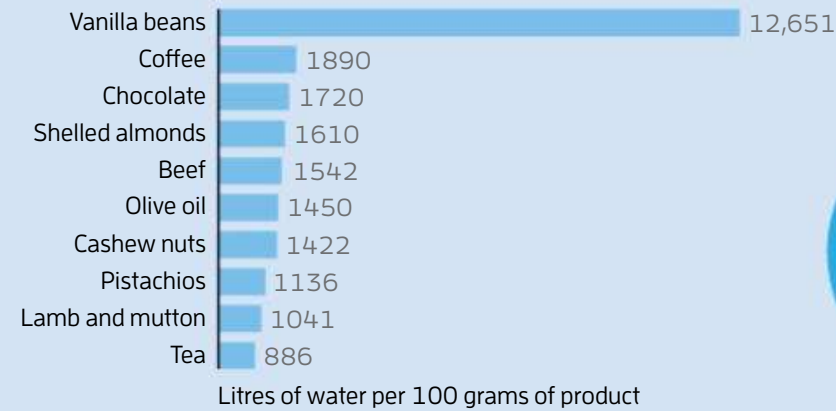
Want to reduce your water consumption? There are changes you can make to the way you use water directly at home, such as installing a water butt if you have a garden or turning off the taps when you brush your teeth. But, perhaps surprisingly, you can have a far greater impact by changing your consumer habits.

Take fashion. Cotton is an especially thirsty crop: it takes about 7500 litres to grow enough for a pair of jeans. Eschewing fast fashion or buying second-hand is a huge water saver. Dietary changes can also have a big impact. Some of the foods that take a lot of water to produce (see top 10, below) aren't so

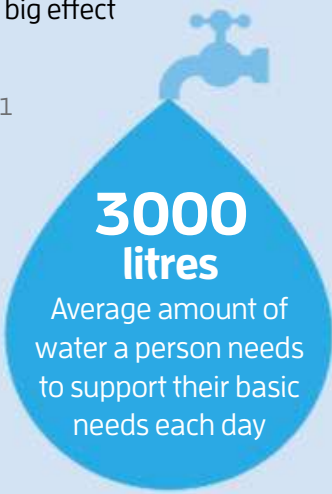
surprising. Animals clearly drink a lot of water as they are reared, so it makes sense that meat has a vast water footprint. But I hadn't previously thought about how much water it takes to grow luxuries like coffee, chocolate and vanilla. Reducing our consumption of these most-thirsty foods could be a big win.

The thirstiest foods

Much of our water footprint comes from growing crops and rearing livestock. This chart shows the 10 most water-intensive foods – we can have a big effect on our personal water consumption by cutting down on these



SOURCE: WATERFOOTPRINT.ORG & DOI.ORG/BHX2NQ



Investing in smart irrigation systems can reduce agricultural water use massively and this pays for itself in one to three years, says commission member Tharman Shanmugaratnam, until recently the senior minister of Singapore, one of the most water-stressed countries in the world. Ditto water use in industry and mining. "We need innovation around recycling industrial waste water," says Mazzucato. "We waste an immense amount of water in how we do industry."

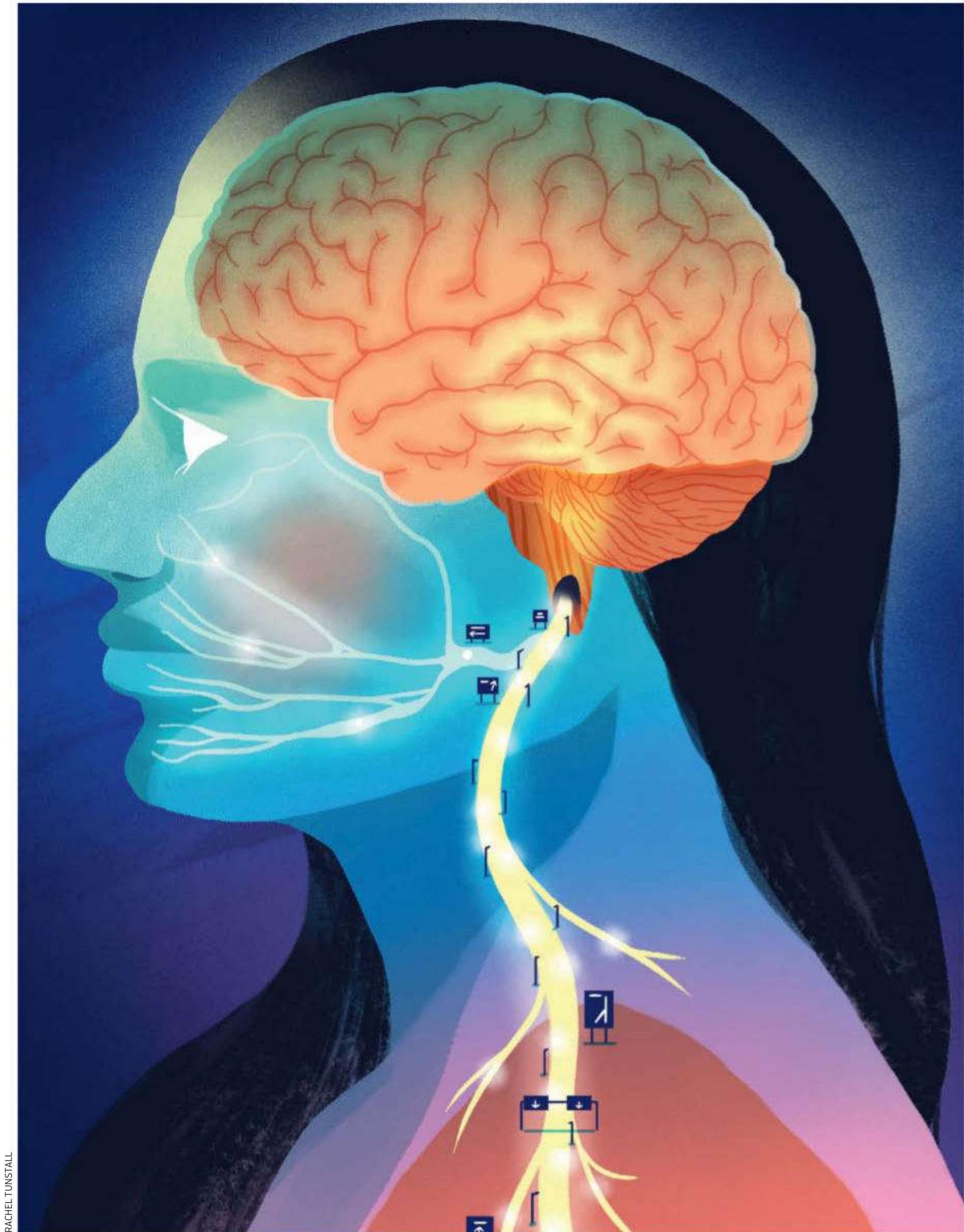
Domestic water supplies are also massively wasteful, and not just because they leak. The UK, for instance, mostly has a mixed sewage system that combines rainwater and human waste and treats them together. "It is absolutely bonkers to take perfectly good rainwater, intentionally mix it with sewage, put a huge amount of effort to get it somewhere, put energy into separating it again, and then flush our toilets with

the fresh water," says Andy Mitchell, CEO of Tideway, a water company that is building London's new "super sewer". What's needed is to create a whole new infrastructure to treat rainwater and sewage separately and use "grey water" from washing machines and dishwashers to flush toilets, he says, but that will take decades.

Yet these efficiency gains will amount to a drop in the ocean unless we fix the fundamental problems. "If you want to be sure you have any water to operate efficiently with, then you need to secure the source, and the source has to be secured by managing the climate and nature," says Rockström. ■



Graham Lawton is a features writer at New Scientist



AS I peered at its sinewy, tentacle-like tendrils, I thought the pale structure splayed on the table before me resembled a huge tapeworm, or perhaps a scrawny squid.

Its lacklustre appearance didn't match with the wonder of what I knew it to be: a human vagus nerve, the sensory superhighway that connects our brain to most of our vital organs and helps regulate everything from the movement of food through our intestines to the steady beating of our heart.

I was at the Feinstein Institutes for Medical Research in New York, viewing one of 30 vagus nerve samples being diced, sliced and imaged by Stavros Zanos and his colleagues. The goal? To create a detailed map of the roughly 160,000 nerve fibres along its structure.

This ambitious effort comes after recent research has revealed the vagus nerve's role in a wider array of processes than we ever realised – not only monitoring organ function, but helping discern facial expressions and even regulating mood. Most enticingly, we are starting to understand how it governs

inflammation, the immune response that runs rampant in conditions ranging from heart disease to Parkinson's.

Already, electrical devices called vagus nerve stimulators are used to treat epilepsy, depression, migraines and obesity. But they are limited by our rudimentary understanding of the nerve's complex structure. Now, efforts to untangle its mysteries are allowing us to map each of its branches and even discover specialised cell types we never knew existed. Not only might these insights enable us to control inflammation, they could open a whole new frontier for precision medicine.

The vagus nerve is a bundle of neural fibres that starts at the brain stem. It splits into two channels that run along either side of the neck, then rejoin at the heart before descending to the gut and other organs.

The earliest evidence of its crucial function dates back almost 2000 years to when the ancient Roman physician Galen accidentally severed a sheaf of nerves in a pig, stopping its squeals but not its squirms. It turned out he had sliced a branch of the vagus nerve

responsible for transmitting signals from the brain to the vocal cords.

Subsequent experiments revealed that the vagus nerve regulates functions of the heart, stomach, lungs, liver and more. But it wasn't until about three decades ago that we began to tap into it for medical treatments.

The earliest success was with epilepsy. In the late 1980s, J. Kiffin Penry and Joan Christine Dean, then at Wake Forest University in North Carolina, showed that implanting a vagus nerve stimulator reduces or even eliminates seizures for some people with the condition. Most of these stimulators use a pulse generator slightly larger than a poker chip, which is implanted under the skin on the chest. This sends electrical impulses via a wire to a cuff wrapped around the vagus nerve in the neck. The first such stimulator was approved by the US Food and Drug Administration (FDA) in 1997 for treating drug-resistant epilepsy.

Since then, the FDA has approved an implantable device for treatment-resistant depression, after trials showed that it lessened symptoms for about 40 per cent of people who had already tried four or more other treatments without success. A device called VBLOC has also been approved for treating obesity: people using it lost about 8 per cent more excess weight than those in a control group. Most recently, the FDA approved a stimulator for regaining upper body movement after a stroke. Research also indicates that stimulators can be used to regulate blood pressure and lower blood sugar.

Most tantalising is the role the vagus nerve plays in controlling inflammation. Hints of this first emerged in the 1990s, when Kevin Tracey, now at the Feinstein Institutes for Medical Research, and his colleagues developed an anti-inflammatory drug to block production of proteins called cytokines, which spur the body's immune response to infection or illness. In modest amounts, cytokines and the ensuing inflammation fend off foreign pathogens and heal injuries, but an overabundance of them has the opposite effect, damaging tissues and potentially causing chronic illness or even organ failure.

Tracey and his team injected their new drug into the brains of rats experiencing stroke from bacterial infections. As they hoped, it dampened inflammation in the brain. But to their surprise, the effect also extended throughout the rodents' whole bodies. ➤

YOUR BODY'S SECRET SUPERHIGHWAY

The vagus nerve influences everything from your heartbeat to your immune system. Unravelling its secrets could usher in a new era of medicine, finds **Grace Wade**

With drugs given orally or intravenously, you would expect widespread effects, but the researchers weren't anticipating this after injecting the medication directly into the brain. "For months, we agonised over what the mechanism could be," says Tracey. Eventually, they tried severing the animals' vagus nerves. "When we did that, the drug in the brain no longer turned off inflammation," he says. "Scientists don't say 'eureka' any more, they say 'holy shit', and that's what happened."

Tracey dubbed the vagus nerve's ability to mediate inflammation the inflammatory reflex. It kicks in when specialised neurons detect cytokines and send signals to the brain, which in turn relays messages to the spleen to start churning out white blood cells. The discovery suggested that we might be able to interrupt inflammation with an electrode, not just drugs, he says.

In 2012, a device using an electrode that Tracey designed while at SetPoint Medical, a biotechnology company in California, was tested in a small group of people with the chronic inflammatory condition rheumatoid arthritis. Of those, 70 per cent had at least a 20 per cent reduction in symptoms, and almost half saw a 50 per cent improvement.

The effect is similar to that of some drugs, but there is a major advantage: anti-inflammatory medications often severely suppress immune function, leaving people vulnerable to infection. Not so with this

approach. Vagus nerve stimulation causes white blood cells to shut down cytokine production enough to avoid runaway inflammation, but not so much that our immune system is disarmed completely, says Tracey.

Mysterious fibres

SetPoint Medical is now conducting a trial of the device in about 250 people. Tracey is hopeful that the FDA could approve the treatment for rheumatoid arthritis within a few years. Meanwhile, similar devices have also shown promise in treating conditions characterised by chronic inflammation, including inflammatory bowel disease, multiple sclerosis and Parkinson's disease.

"What diseases are affected by inflammation? Pretty much every chronic illness," says Zanos. "I'm not saying vagus nerve stimulation will work for every single one of them, but it makes sense to test it out in some way or another."

There is just one hiccup in all of this: how exactly these treatments work is largely a mystery. It is unclear which fibres the stimulators even target. Is it those closest to the electrode? The ones furthest away? The small ones? The large ones? We simply don't know. We just turn on the device and hope for the best.

With obesity, for instance, the stimulator is meant to work by mimicking signals that travel along the vagus nerve to tell the brain to stop eating when the stomach is full. In people with epilepsy, though, vagus nerve devices

may provide benefits by stimulating nerve cells that increase blood flow to a brain region called the thalamus, which processes information from most senses. It may also work in part by triggering the release of the neurotransmitter noradrenaline, which can reduce seizure symptoms. Boosting noradrenaline may be the way stimulation eases depression symptoms, too. But which particular nerve fibres play a role in this is unknown.

It is even trickier to pin down exact targets of devices that zap the vagus through the skin. Today, these transcutaneous stimulators can be purchased in many countries without a prescription from about \$200. They are often marketed as a way to boost "vagal tone", a supposed measure of vagal activity. But researchers say the concept isn't terribly scientific (see "What is vagal tone?", right).

Some transcutaneous stimulators have been rigorously tested, though. In 2018, the FDA approved one for treating chronic migraines and cluster headaches after research showed that it significantly lowered the number of days that people experience them. Tracey says it is important to talk with your doctor before using this kind of technology. These devices may not be suitable for some people with heart conditions, as they can affect heart rhythms.

Therein lies the problem. The extraordinary complexity of the vagus nerve is what makes it an avenue for improving so many aspects of health, but the lack of specificity in treatments also means they can have unintended side effects. It may also be why some applications simply fail.

"The way neuromodulation has been done for many years is creating an electrode and then placing it on a nerve or in the brain and hoping for the best," says Zanos. For more consistent results, and to expand the potential applications, we need a much more detailed understanding of what we are aiming for.

All of which explains how I find myself staring at the stringy tissue in Zanos's lab. He and his colleagues are embarking on a three-year, \$6.7-million project funded by the US National Institutes of Health to map the vagus in its entirety. That involves identifying every single nerve fibre and tracking its location along the structure's meandering pathway.

It is painstaking work, beginning with the process of extracting the vagus nerve from a cadaver. At points, it is thinner than a cotton thread, and researchers must carefully label

Cold water swimming is supposedly a way to enhance "vagal tone"



What is vagal tone?

Contemplative activities, including yoga, tai chi and meditation, can slow respiration and, in turn, affect signals travelling along the vagus nerve. Extreme athlete Wim Hof, for example, swears by his daily dunks in ice-cold water and militant breathing routine to reduce inflammation by improving vagal tone, a supposed measure of electrical activity along the vagus nerve.

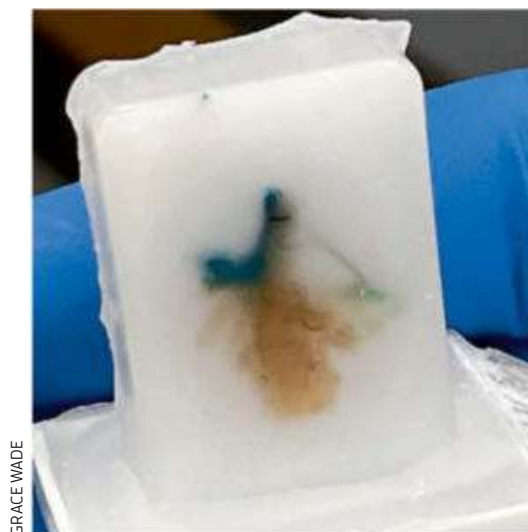
But what is vagal tone really, and is it actually something you can strengthen? When I ask Kevin Tracey at the Feinstein Institutes for Medical Research in New York, he cradles his head in his hands and groans. "It is a non-scientific term that is difficult to define, and because it is difficult to define, I think it is misappropriated," he says.

One issue is that it is almost impossible to directly gauge vagus nerve activity, so another measure called heart rate variability – or the variation in timing between heartbeats – is used as a stand-in. But research in rats shows heart rate variability doesn't correlate well with vagal output.

Even if people could reliably calculate the vagus nerve's firing capacity, it probably wouldn't do much good given the structure's dizzying complexity.

"People tend to think and talk about the vagus nerve like a single, solid copper wire," says Tracey. "But it's more like 160,000 wires, each of which can control a very specific function."

"Vagal tone implies that there is one function of the vagus nerve," says Stephen Liberles at Harvard University. But many fibres in the vagus have opposing effects (see main story). "So there is no vagal tone. It is a bit of a misnomer," he says.



Sections of the vagus nerve are encased in wax, then sliced thinly

what organs its many branches connect to.

The researchers then chop it into pieces that, at their thickest, resemble cannellini beans, which are moulded into blocks of wax. These are placed into what is essentially a deli meat slicer, where the encased nerve sections are shaved into slivers as thin as a human hair.

Finally, the team bathes the segments in staining solutions to reveal their inner complexity. Zanos shows me an image on his computer. What was once a rather dull, brown blob is now a motley of red, green and blue fluorescence. Each colour correlates to a different type of nerve fibre, yielding clues to its function, he says.

We can tell what types of signals neurons ferry based on their distinct anatomical features. Afferent neurons transmit sensory information towards the brain, while efferent neurons relay signals for controlling movement from the brain to our muscles. Fibres that are insulated in a fatty coating called myelin generally fire faster than those without it. "So, if it is myelinated and efferent, we know that most likely mediates muscle contractions," says Zanos.

Mapping the vagus nerve's anatomy won't only allow us to better predict the effects of placing an electrode anywhere along the nerve's structure, but could also lead to the creation of ultra-selective stimulators that act only on certain fibres, he says.

Zanos and his colleagues have already shown proof of this concept. After they mapped the vagus nerve of pigs, they developed an ultra-selective vagus nerve stimulator with 10 separate contact points. In research published earlier this year, they showed that, when implanted into live pigs, the device altered the animals' breathing while minimising effects on other organs.

Mapping the vagus nerve is just the first step, says Cristin Welle at the University of Colorado. "The next step is going to be, how do each of those fibre types then interact with the rest of the nervous system?" she says. She and her team are charting the vagus nerve in the opposite direction, identifying which brain regions it activates. Last year, they showed that vagus nerve stimulation targets neurons in the primary motor cortex of mice, enhancing the animal's ability to learn motor skills.

Stephen Liberles at Harvard University believes we can achieve even greater precision by elucidating the mechanisms of specific neurons with genetic sequencing. Of particular interest are sensory neurons, which constitute about 80 per cent of all nerve fibres in the vagus and use specialised receptors to detect changes in an environment. "Some of our landmark discoveries in the external senses were discovering odourant receptors or vision receptors," says Liberles. "We don't know the receptors for almost any internal organ sense."

Conducting traffic

Already, he and his colleagues have identified previously unknown types of vagal neurons that mediate breathing, control blood pressure and detect nutrients in the gut. He believes we will eventually be able to develop drugs that act only on specific vagal cells. If the vagus nerve is our body's superhighway, such drugs would control the movement of individual cars, while vagus nerve stimulators would dictate general traffic flow across multiple lanes.

"When you understand how all these vital body-to-brain communication pathways operate, that will open the door to therapies by which you can toggle [these] different pathways with greater selectivity," says Liberles. Being able to modulate inflammation or other physical functions with this level of precision would be nothing short of game-changing for modern medicine.

As I leave Zanos's lab, I steal a final look at the ribbon of white tissue, marvelling at its extraordinary potential – and the power of science to map it and manipulate it. ■



Grace Wade is a health reporter for New Scientist

Puzzles

Try our crossword, quick quiz and logic puzzle **p45**

Almost the last word

Is it more efficient to open car windows or run the air con? **p46**

Tom Gauld for New Scientist

A cartoonist's take on the world **p47**

Feedback

The pitfalls of texting, plus breaking down autophagy **p48**

Twisteddoodles for New Scientist

Picturing the lighter side of life **p48**

Debunking gardening myths

Behind closed doors

Houseplants are having a moment, but there is no need to worry about keeping them in your bedroom at night, says **James Wong**



James Wong is a botanist and science writer, with a particular interest in food crops, conservation and the environment. Trained at the Royal Botanic Gardens, Kew, in London, he shares his tiny flat with more than 500 houseplants. You can follow him on Twitter and Instagram @botanygeek

ONE of my favourite old-school gardening beliefs, which recently resurfaced with the explosion of interest in houseplants, is that it is inadvisable – even dangerous – to have plants in the bedroom.

This centres around the claim that while plants take in carbon dioxide and release oxygen in the day, at night this is reversed, so they compete with us for the very air we breathe while asleep. The build-up of CO₂ is a genuine problem for indoor air quality, which has been demonstrated to have health impacts, so it is easy to see where the concern stems from. But to establish whether sharing our bedroom with our plants is actually a risk to health, we have to consider three things.

Firstly, how much CO₂ do plants emit at night compared with what they absorb in the day? This is tricky to answer as it depends on everything from species to light levels and even room temperature – and the research on the precise metrics in an indoor setting is pretty thin on the ground. Thankfully, in 2015, researchers at Turkey's Kastamonu University found that large houseplants like ficus and yuccas, when sealed in glass boxes, absorb between six and eight times as much CO₂ in the day as they emit at night, creating a pretty hefty net reduction over the full 24-hour period.

And the impact they had on CO₂ levels overnight wasn't exactly enormous. Ficus, for example, created an increase of 351 parts per million by morning,



which kept the levels in the boxes well within the healthy range for humans.

Secondly, we should compare the nocturnal impact of plants on air quality with that of other potential competitors, such as a partner. A single human breath contains around 40,000 ppm of CO₂, more than 10 times the effect a plant could have in 8 hours, so you might want to turf your partner out before your plants.

That is before we even consider that indoor plants, typically grown at light levels far lower than their ideal range in their native habitat, photosynthesise at a much lower rate, reducing impact further.

Finally – and this may sound a bit obvious – we don't live in the hermetically sealed boxes in which these studies are carried out.

Indoor air is constantly being exchanged through built-in ventilation, under doors and windows, even just from humans moving around the space. According to one recent review, you would need between 100 and 1000 plants per square metre of floor space to mimic the impact of an open window on keeping inside air fresh, given that plants remove some pollution. In conclusion, the pot plant effect in our homes is minimal in many ways.

So enjoy houseplants whenever you like, because, frankly, if sleeping near plants were bad for your health, camping in a forest would be positively deadly. ■

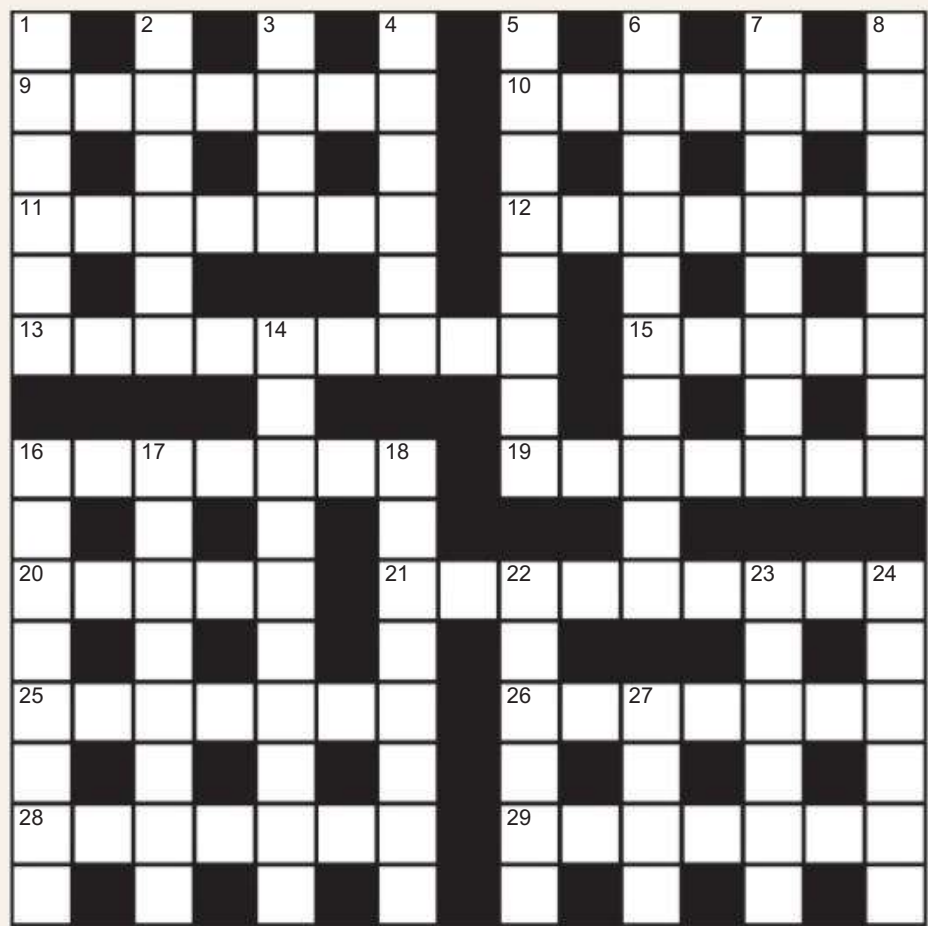
Debunking gardening myths appears monthly

Next week

The science of cooking

These articles are posted each week at [newscientist.com/maker](https://www.newscientist.com/maker)

Quick crossword #140 Set by Richard Smyth



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

- 9** Eighth planet from the sun (7)
10 Jean-Baptiste ___, French evolutionist (7)
11 Goose species, *Anser anser* (7)
12 Hydrocarbon found in carrots (7)
13 Colourless gas, C₂H₂, used as a fuel (9)
15 Nostrils (5)
16 Mountain woodland plant in the family Saxifragaceae (7)
19 Spiny anteater (7)
20 Final life-cycle stage (5)
21 Mushroom (9)
25 Microscopic organism sometimes called a wheel animal (7)
26 Michael ___, English scientist (7)
28 Cut off (7)
29 Surgical scraping tool (7)

DOWN

- 1** ___ machine, Nazi cipher device (6)
2 1987 sci-fi thriller by Michael Crichton (6)
3 Yank; tow (4)
4 ___ fever, mosquito-borne tropical disease (6)
5 Bruising of the orbit (5,3)
6 Plant genus that includes Prince-of-Wales feather (10)
7 Dented by meteor or bomb impacts (8)
8 Inability to move (8)
14 Quarantine signal; iris species (6,4)
16 Low-pH precipitation (4,4)
17 Force generated through friction (8)
18 Keyboard component, often equivalent to an "OK" button (5,3)
22 Influence; have an effect on (6)
23 Space ___, 1969 David Bowie song (6)
24 ___ jar, archaic electrical component (6)
27 ___ earth, metal such as Ce, Eu or La (4)

Quick quiz #216

set by Bethan Ackerley

- 1** What is the only dwarf planet in our inner solar system?
2 Who first synthesised the psychedelic compounds lysergic acid diethylamide (LSD), psilocybin and psilocin?
3 Tetralogy of Fallot is a congenital condition affecting which organ?
4 Who first posited the existence of neutrinos?
5 Pleopods are appendages that primarily aid in which activity?

Answers on page 47

Headscratcher

set by Brian Hobbs

#236 Picky eaters

My young kids don't mind helping to carry in the groceries, especially in pursuit of the ultimate prize: getting to be the one who pushes the button that closes the automatic rear door of our minivan. So, as they go back and forth carrying the groceries to the house, I have told them that the one who takes the last item or bag out of the van gets to close the door.

Today, two of my children are with me, and we have just arrived home with a big bag of potatoes, two boxes of fizzy drink and three bags of general groceries. They can carry at most two grocery bags at once (amateurs), two boxes of fizzy drink at once or the heavy bag of potatoes all by itself. Because of how each item is carried, they can only take one type of container at a time, so they won't be able to carry a case of soda and a grocery bag on one trip.

They will take turns carrying one or two items into the house, and Georgia gets to go first. What should she pick to ensure that she takes the last item and gets to push the magic button?

Solution next week



Our crosswords are now solvable online
[newscientist.com/crosswords](https://www.newscientist.com/crosswords)

Blow or chill

Driving in summer, I can cool my car by using air conditioning or opening the windows. One drains the battery, the other makes the car less aerodynamic. Which is more efficient?

Graham Jones

Bridgham, Norfolk, UK

It would be much better to use the air conditioning rather than open the windows.

As far as I know, all car air conditioning systems are run directly from the engine, via a drive belt such as the one used for the alternator, water pump and power steering. A small amount of electricity will be used for the control mechanism, air blower and the like, but the electrical power comes from the alternator, so the battery isn't drained.

Early systems (typically in US cars of 60 years ago) operated the coolant compressor at maximum cooling and there would be manual or automatic mechanisms to mix the very

“For an electric vehicle, it is estimated that using the car's air conditioning can reduce range by about 10 per cent”

cold air with warmer air from the heating set-up. These systems would take a significant proportion of the available engine power and vehicle performance suffered noticeably as a result.

More modern versions are rather more efficient, but in the UK, some entry-level car air conditioning systems still operate the compressor at maximum cooling. Most modern cars, however, are more sophisticated and use a variable displacement compressor. A control system ensures that only just enough power is taken from the engine to maintain the desired inside temperature.

The cooling mechanism dries



DAVID STEELE/ALAMY

This week's new questions

Worn down How long will it be until the pyramids in Egypt weather away completely? *Gideon Wegh, London, UK*

Hot property Would it be theoretically possible to build a large habitable dome on the surface of Venus, one of the most inhospitable places in the solar system? *Kieran Evans, Horley, Surrey, UK*

the incoming air. This helps with screen demisting, and I think many modern cars rely on using the air conditioning to provide demisting. So the air conditioning is actually a safety aid.

By contrast, if you open a window and drive faster than a walking pace, the air turbulence creates very significant drag. Open rear windows in particular make a lot of noise and generate buffeting that can be very distressing for the driver. So opening the windows is generally a very bad idea.

The issue becomes more relevant for electric vehicles. I have seen estimates of air conditioning reducing their range by about 10 per cent. But a more relevant figure is that using the heating reduces range by about 15 per cent,

and this will be particularly relevant in cold weather when screen demisting or de-icing is required and the cold reduces battery capacity.

Martin van Raay

Culemborg, The Netherlands

A 2004 study concluded that below 45 miles per hour (72 kilometres per hour) it is more efficient to open the windows, as over this speed the aerodynamics increases the fuel consumption of the car more than the power the air conditioning draws.

Mind you, you don't have to open all the windows all the way to get the cooling effect of the wind blowing over your skin. So the cut-off speed might actually be higher than 45 mph. Also, on a sunny day, use a windshield sun shade, so

When will the pyramids in Egypt have weathered away completely?

your parked car heats up less.

I use an ice/frost shield with an outer layer of aluminium. It keeps ice from my windshield in winter and keeps the heat out in summer. If you live in the Netherlands, you might know the following joke: “This car does not have airco; it has ARKO!”, where ARKO stands for “alle ramen kunnen open” (“all windows can open”).

Guy Cox

Sydney, Australia

First of all, unless Penny, who posed the question, is driving an electric car, air conditioning doesn't drain her battery – it is powered by a belt from the engine. So it will, of course, increase her fuel consumption. How much it does this depends on the type of car she is driving – less if it runs on diesel, since such cars are more fuel efficient.

On the motorway, it will pretty much always be better to shut the windows and use the air conditioning. And she probably couldn't stand driving at motorway speeds with the windows open anyway.

Given that extreme heat is rare in Cumbria in the UK where she lives, she would probably do better by opening windows when meandering through quiet country lanes. In between – well, she would have to test for herself.

Dennis Doren

Lake Mills, Wisconsin, US

The dilemma about use of air conditioning or open windows was scientifically answered by the TV programme *MythBusters* some years ago. It measured fuel consumption to gauge the impact of these options. The finding was that open windows were more efficient than air conditioning when the car was travelling at or below about 40 mph (64 km/h), but air conditioning was more efficient than open windows above that velocity.



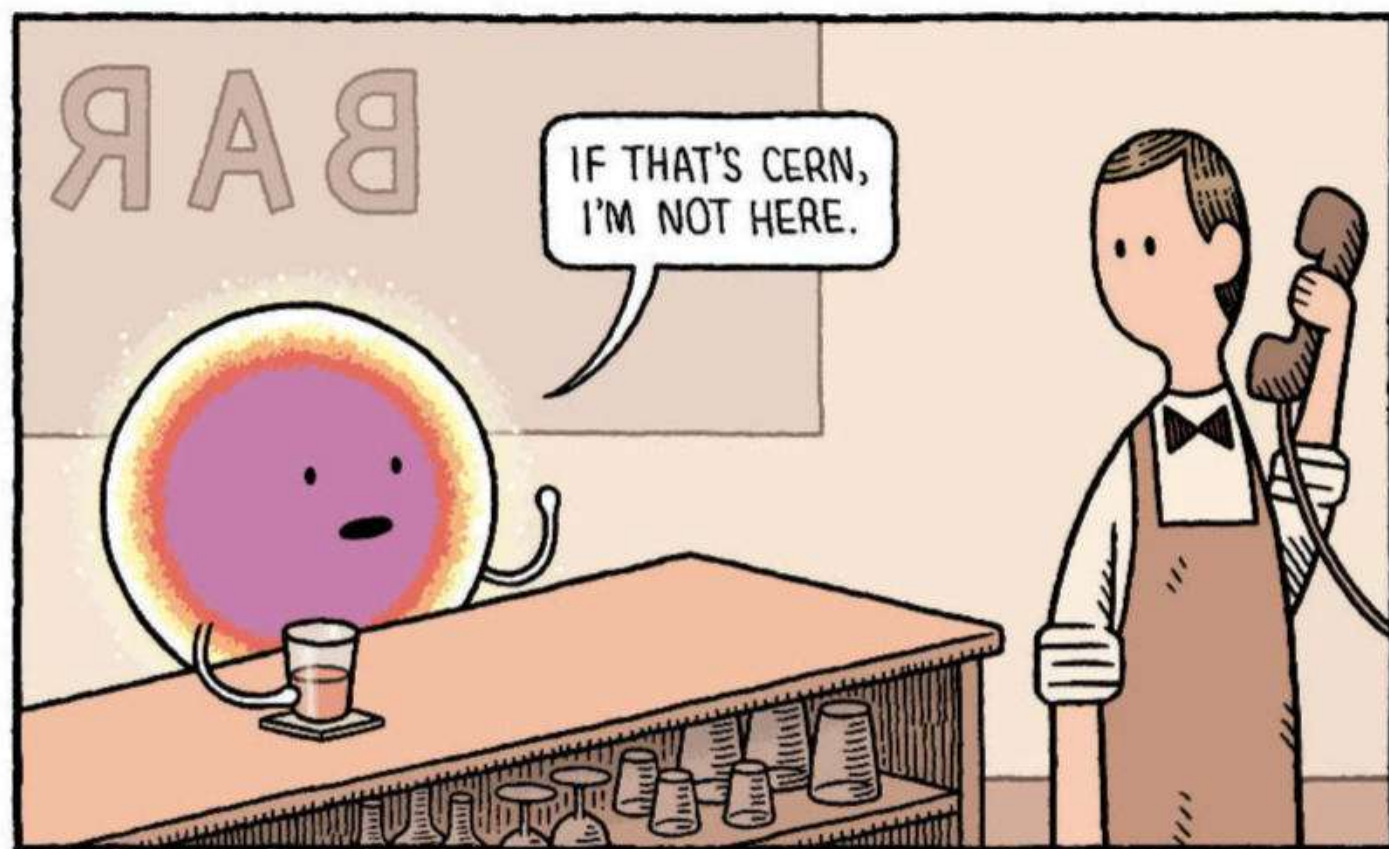
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Tom Gauld
for *New Scientist*



Dirty mutts

Why do cats wash themselves, while dogs don't? (continued)

Adam Harding

Porthcawl, Bridgend, UK

Both dogs and cats secrete oils into their fur that interact with sunlight to produce vitamin D, which they ingest when they lick it off their coat. It could be that cats need a lot more of it than dogs.

Trevor Lowe

Melbourne, Australia

Dogs do wash themselves and frequently pick the most inopportune time to clean their private parts (visitors/grandma present). Cats may be more fastidious and more frequent cleaners. The fact that dogs groom themselves less often may be where the phrase "you dirty dog" came from.

Gavin Spickett

Prudhoe, Northumberland, UK
I read with interest the earlier correspondence you carried

"Dogs do wash themselves and frequently pick the most inopportune time to clean their private parts"

about this question (22 July).

It isn't true that dogs don't wash. We have a springer spaniel who hates being dirty: he avoids mud and puddles and doesn't roll in filthy things, although he does like swimming in rivers and the sea (but only when it is hot). He spends a lot of time washing all parts of his coat that are in reach of his tongue, as well as adjusting the fur with his front teeth. He also washes his face like a cat by licking his paws and then rubbing his face.

We believe that he may have been a cat in a previous incarnation and therefore think that he is proof of Buddhist reincarnation. The higher being would obviously have a sense of humour to reincarnate a cat as a dog!

Early riser

When was the first sunrise on Earth? (continued)

Bart Stork

The Netherlands

The first "sunrise" was the one seen by the first human who had evolved the cognition that enabled them to think and conclude the sun was rising above the horizon. My best guess is this was between 150,000 and 200,000 years ago, but I stand to be corrected.

Phil Taylor

Broadwell, Oxfordshire, UK

It was fun to read the two distinct groups of earlier replies to this question. According to these, the answer mostly seems to be either to do with when Earth could be called "Earth" or when the sun was able to penetrate the atmosphere.

As someone who lives in the UK, I can't support the second view, as we frequently have days when the sun can't be seen through clouds, yet will still say that it has risen and count it as a day. ■

Answers

Quick quiz #216 Answers

- 1 Ceres, which is located in the asteroid belt between Mars and Jupiter
- 2 Albert Hofmann
- 3 The heart
- 4 Wolfgang Pauli
- 5 Swimming – they are found in crustaceans

Cryptic crossword #116 Answers

ACROSS 1 Pubs, 3 Atom bomb, 9/23 Stomach acid, 10 Cased, 11 Indri, 12 Nested, 14 Squeal, 16 Phlegm, 19 Apollo, 21 Fluid, 24 Charm, 25 Itemise, 26 Deathbed, 27 Ceps

DOWN 1 Pushiest, 2 Blood, 4 Tahini, 5 Mucus, 6 Obscene, 7 Body, 8 Saliva, 13 Smidgens, 15 Uppsala, 17 Hefted, 18 Mobile, 20 Lymph, 22 Urine

#235 Sneak a peek Solution

You need to buy five sneak-peeks if you want to guarantee winning the prize.

There are various ways to do this. For example, look under pots 2, 4, 6 and 8. If one of them (e.g. 4) has a key, spend your last peek on one of its neighbours (e.g. 5). You will then know if the keys are under 4 and 5 or 3 and 4. If none of 2, 4, 6 or 8 has a key, the keys must be under 9 and 10. Another strategy is to choose 2, 5, 6 and 9. If none has a key, spend your last peek on one of the remaining pots (aside from 1 and 10) to decide if the keys are under 3 and 4 or 7 and 8.

Down, with texting

Want to guess what might happen if someone walks while texting?

If you prefer a formally educated guess to an autodidactic supposition, Paulo Pelicioni and his colleagues at the University of New South Wales, Australia, can supply it. Having studied the matter, they say: "Using a mobile phone to text while walking may compete with locomotor tasks, threat assessment and postural balance control mechanisms, which leads to an increased risk of accidental falls in young adults."

The researchers analysed the adventures of 50 "healthy young adults" in a 10-metre-long hallway. They tell the story by implication – note their efficiency in choosing the word "impact" – in the title of their study: "Impact of mobile phone use on accidental falls risk in young adult pedestrians."

To summarise: while texting, a spring in the step can lead to a fall. What happens to people who have passed the "young adult" stage of life and reached the winter of their existence? The report does not presume. Instead, meticulously, it states: "Future research should further investigate the impacts of mobile phone use in other cohorts including... older adults."

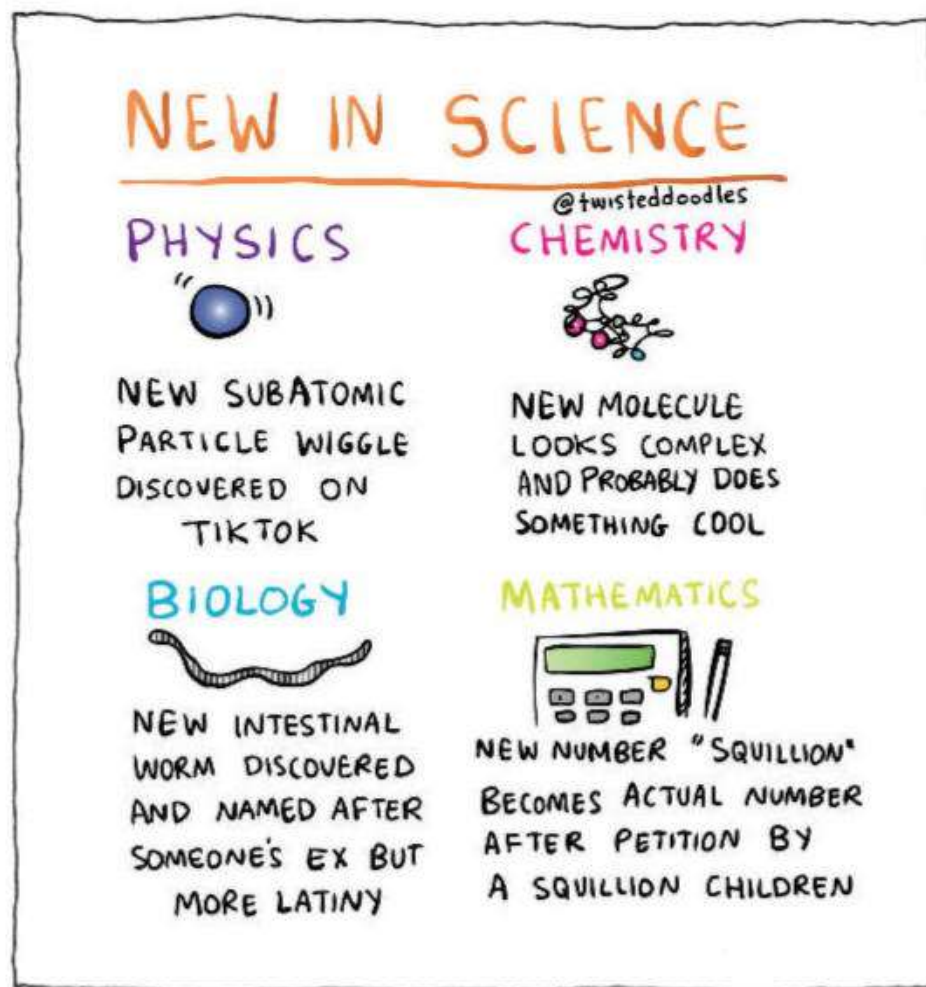
Man of more letters

The lengthy list of 16 academic abbreviations attached to a person's name, as noted by Feedback last month (15 July), failed to impress Ian Glendon.

He says: "Your correspondent's piffling 16 post nominals falls short of those in correspondence I had with an erstwhile colleague at the end of 2022 – who may have added more since – but who had these 22 at that time: BEd, BSc, MSc, MBA, MPH, MLitt, PhD, DLitt, MIAI, MIEnvSc, FEPS, FSyI, PFHEA, FCIEHF, C.ErgHF, CGeog, CMgr, CSyP, CFCIPD, CPsychol, FAcSS, CCMI."

Rendered curious, but possessing only the information Ian provided, Feedback turned to Google, which turned up exactly

Twisteddoodles for New Scientist



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Consideration of items sent in the post will be delayed

one person who fits Ian's description. A certain research chair in risk and resilience at the University of Glasgow Business School, UK, comes thusly adorned: BEd, BSc, MSc, MBA, MPH, MLitt, PhD, DLitt, MIAI, MIEnvSc, FEPS, FSyI, PFHEA, FCIEHF, C.ErgHF, CGeog, CMgr, CSyP, CFCIPD, CPsychol, FAcSS, CCMI.

Feedback notes that anyone who trudges, unslowed, through life with that many letters affixed to their name is a banner example of resilience.

Autophagy for all

Some guidelines are brief, others a lot less so. A research journal article called "Guidelines for the use and interpretation of assays for monitoring autophagy (4th edition)" is less so. The article is 382 pages long. It includes a

reference list that has 4068 items.

It also has approximately 2930 co-authors. (Feedback counted them, but isn't confident in the accuracy of that count. The co-authors seem a bit shaky about their own ability to count. They say: "In a rapidly expanding and highly dynamic field such as autophagy, it is possible that some authors who should have been included on this manuscript have been missed.")

The article was published in 2021 in a journal called *Autophagy*. In the tradition of specialist journals that are distinctly not aimed at non-specialists, nowhere do the guidelines tell the meaning of the word "autophagy". Rather the opposite. The article says: "It is important to note that in this set of guidelines the term 'autophagy' generally refers to macroautophagy."

Non-specialists must go

elsewhere (the usual elsewhere: an internet search engine, a paper dictionary or a clever 10-year-old child) to find the meaning of the word "autophagy". But the article isn't without interest for non-specialists, if only for the mention on page 114 of the word clockophagy.

The article points to an informative future: "These guidelines are likely to evolve as new methodologies are developed and current assays are superseded."

A jarring superpower

Ken Bradley adds a numberific trivial superpower to Feedback's ever-expanding catalogue.

He says: "Two years ago, our 9-year-old grandson J., at his school in Australia, won no less than four competitions for the best estimate of the number of sweets (or, in one case, pencils) in a large jar. This month, now aged 11 and at school in England, he again won a prize, at a summer fete, by estimating that there were 584 sweets in a jar. The correct answer, according to the organisers, was – 584! J. had no 'inside knowledge' and tells me it isn't guesswork. His twin sister has many talents; but not this one."

Pleasing everyone

"You can't please everyone," says a report ("Remove, reduce, inform: What actions do people want social media platforms to take on potentially misleading content?") by Shubham Atreja, Libby Hemphill and Paul Resnick at the University of Michigan School of Information.

Their conclusion echoes many conclusions, from many times, about many subjects. The lament always reduces to those same four words: "You can't please everyone." Is the statement true? Or, au contraire, is there something that DOES please everyone?

If you know of just such a thing – a thing that pleases everyone – please send reliable documentation to "Pleasing Everyone", c/o Feedback. ■

Marc Abrahams

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